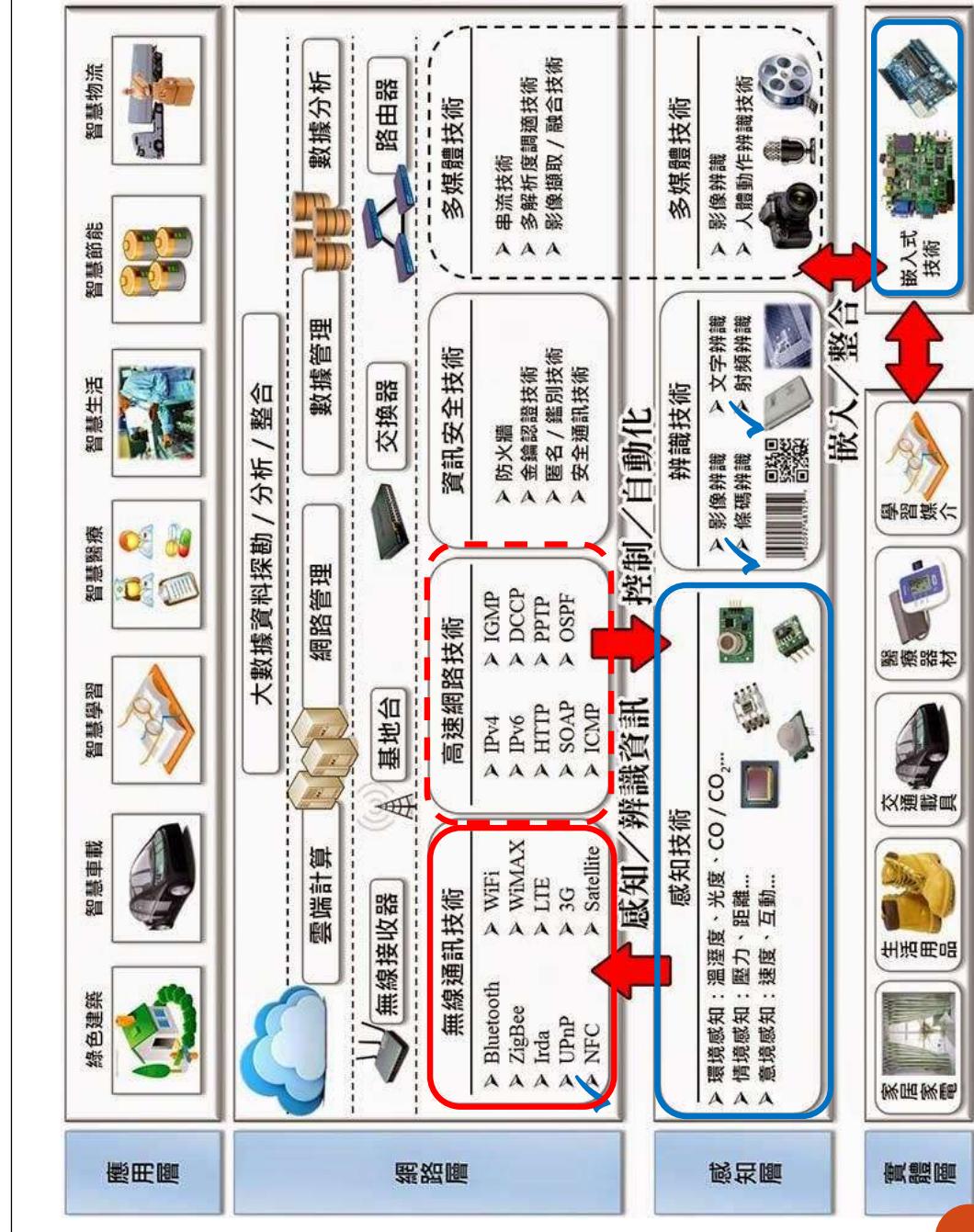


Lecture 3

Wireless Communication



- Wireless Communication (無線通訊)

- NFC ✓
- WiFi, Bluetooth, ZigBee
- IrDA, UPnP, ...
- 4G, 5G, LTE, ...
- High-Speed Network (高速網路)
 - IPv4, IPv6
 - HTTP, SOAP, ...
 - ...

3

- 無線通訊技術基本需求

- 低成本
 - 低功耗
 - 低門檻
 - 高安全性
 - 高支援性 (跨作業系統)
 - iOS、Android、Windows、Linux、...
 - ASA、OIC、OCF、Thread、...
 - Google、Apple、Amazon、...
 - 支援多種標準
- 可輕易連結裝置或網際網路
 - 具認證與加密機制

4

Wi-Fi、藍牙、ZigBee—無線通訊三強，誰主沉浮？

撰編：王奕超

最後更新時間：7月 130日，2022

32920



https://www.ibttmag.com.tw/new_article_result.asp?secu_id=HCP011&search_security_id=24983

5

- **Wi-Fi**

- 1997
- 涵蓋的發展面最廣：2.4GHz、5GHz、6GHz
- 傳輸距離長、傳送速率高、高耗電

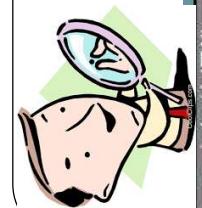
- **Bluetooth**

- 1999
- 安全性高、有效的傳輸距離較短、低耗電

- **Zigbee**

- 2001
- 低傳輸速率、低成本、省電、安全、專用於設備間的溝通

6



3大無線標準		WiFi	藍牙	ZigBee
各項				
台灣適用頻段	2412 ~ 2461MHz、 5250 ~ 5350MHz、 5470 ~ 5725MHz、 5725 ~ 5825MHz ³	2.4GHz		2.4GHz, 800MHz and 900MHz
最高傳輸速率	300 Mbit/s	24 Mbit/s	250Kbps	
可傳輸距離	100-300M	10-100M	50-300M	
安全性	普通	高	中	
功耗	高	中	低	
成本	高	中	低	
應用範圍	廣泛應用於手機、平板、桌電、筆電、數位電視等各類可連接無線網路的裝置	適用於手機、平板、桌電、筆電、電腦周邊、數位電視、遊戲機、耳機、立體音頻串流、汽車、穿戴裝置	專注於各種自動化設備、無線感應裝置、遠端遙控設備	

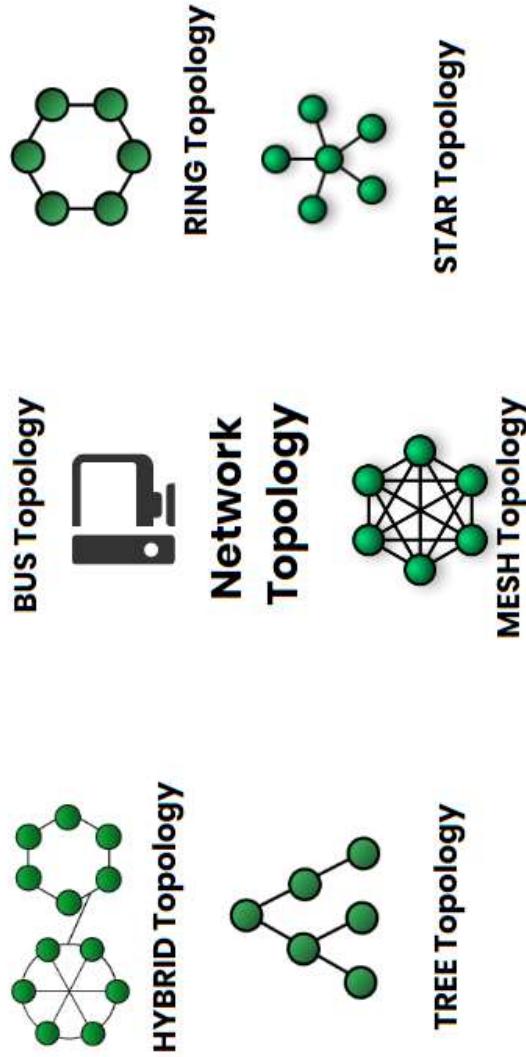
Wi-Fi、藍牙、ZigBee比較表

7

	Wi-Fi	Bluetooth	Zigbee
Range	1	3	2
Data rate	1	2	3
Power Consumption	3	2	1
Topology	1-1 or 1-N	1-1 or 1-N	M-N
Applications	網絡互聯 多媒體串流	音頻串流 穿戴裝置	工業控制 感測網路
Security	3	1	2

8

Types of Network Topology



9

Wi-Fi 7



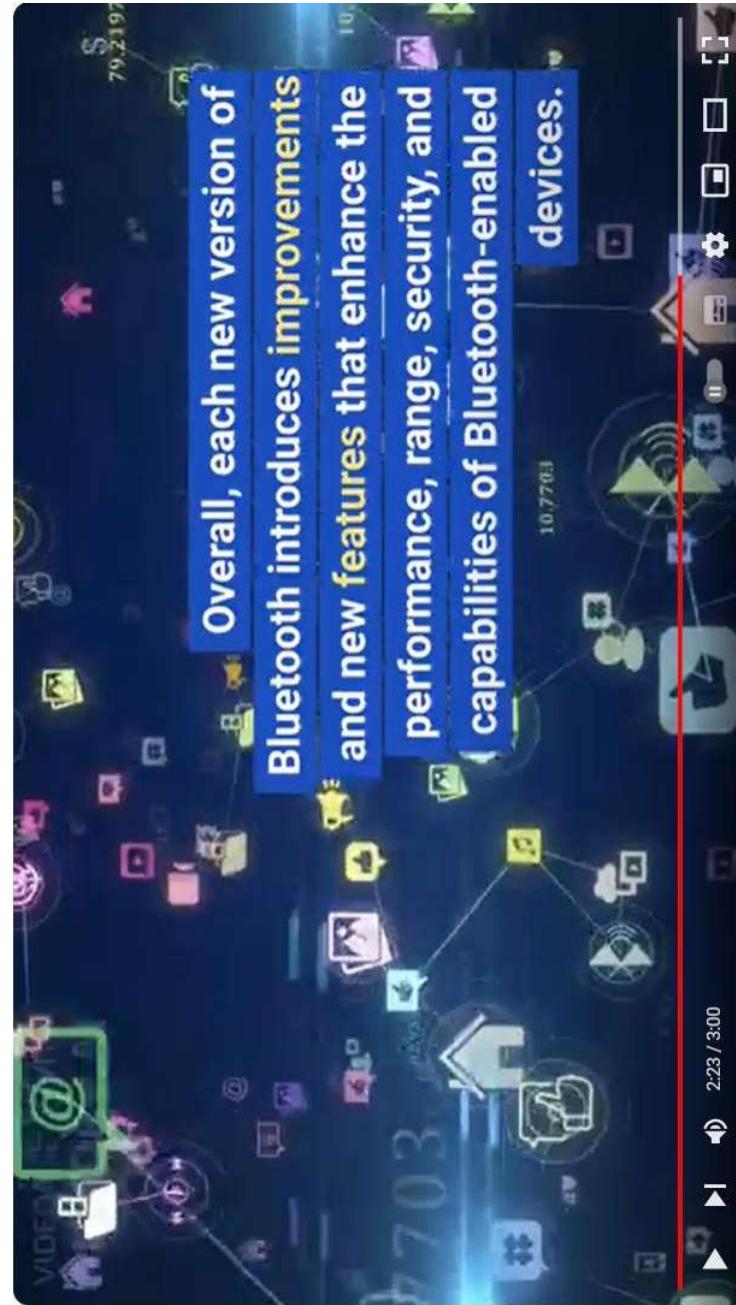
Wi-Fi 7題材準備大爆發 台廠PA三雄出貨看增 無線網路新紀元 今年估2億
台設備採用Wi-Fi7 | 非凡財經新聞 | 20240115

<https://www.youtube.com/watch?v=2WCK01r9KQA&t=11s>

10



Bluetooth 5.3



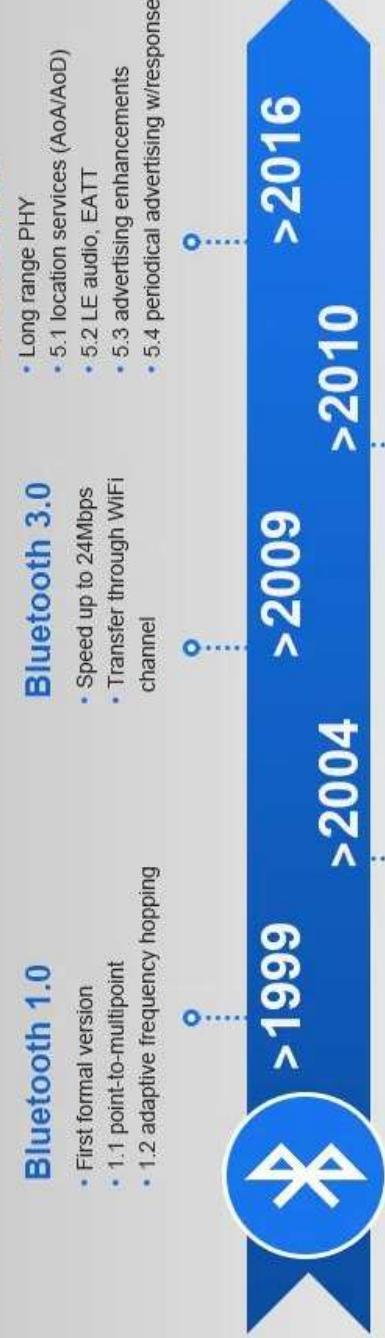
Difference Between Bluetooth 5.0 and 5.1 and 5.2 and 5.3 versions
<https://www.youtube.com/watch?v=f86MloxDyMI&t=109s>

獨特之處	藍牙5.3	藍牙5.4
通訊方式	改進後的單向廣播	透過 PAWR 進行雙向、無連接
數據保障及安全	增強加密金鑰控制	加密廣告數據，確保安全廣播
電源管理應用	低功耗模式的連接子等級	針對大規模物聯網網路進行最佳化
渠道管理	增強頻道分類	透過廣告編碼選擇改進錯誤修正
具體用例	穿戴式裝置、智慧家庭、物聯網設備	物聯網網路、智慧零售（ESL）、感測器網絡

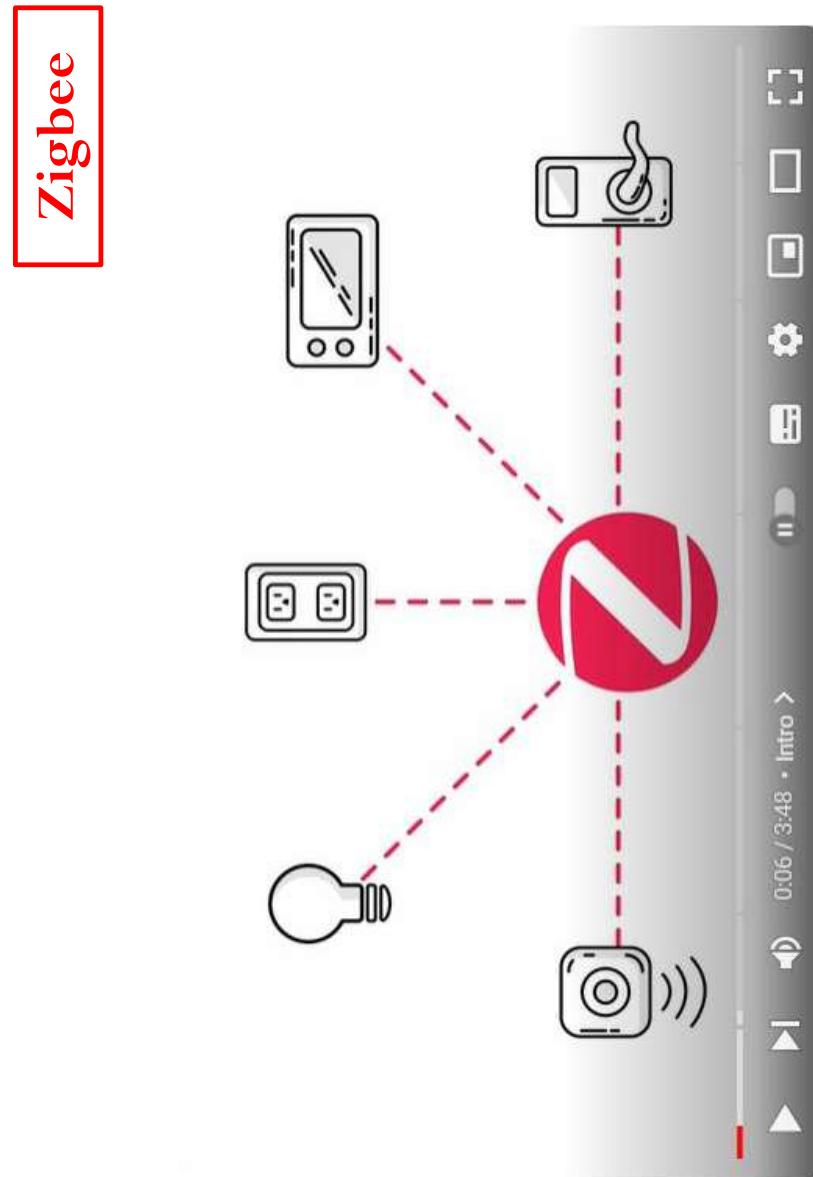
<https://www.alovaaudio.com/zh-TW/bluetooth-5-3-vs-bluetooth-5-4/>

物聯網應用表

應用領域	藍牙 5.3 適用性	藍牙 5.4 適用性
穿戴式	高（節能、連結穩定）	中等（旨在快速響應）
智能家居設備	高（高效用電）	高（處理許多低功率設備）
工業傳感器	中（基本連接）	高（支援龐大的感測器網路）
零售（ESL）	低（未針對此用例進行最佳化）	高（標準化 ESL 設定檔）



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What is Zigbee?

<https://www.youtube.com/watch?v=2p8G6JMvgUw&t=2s>

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<https://cn.gii.tw/report/moi1642171-zigbee-market-share-analysis-industry-trends.html>

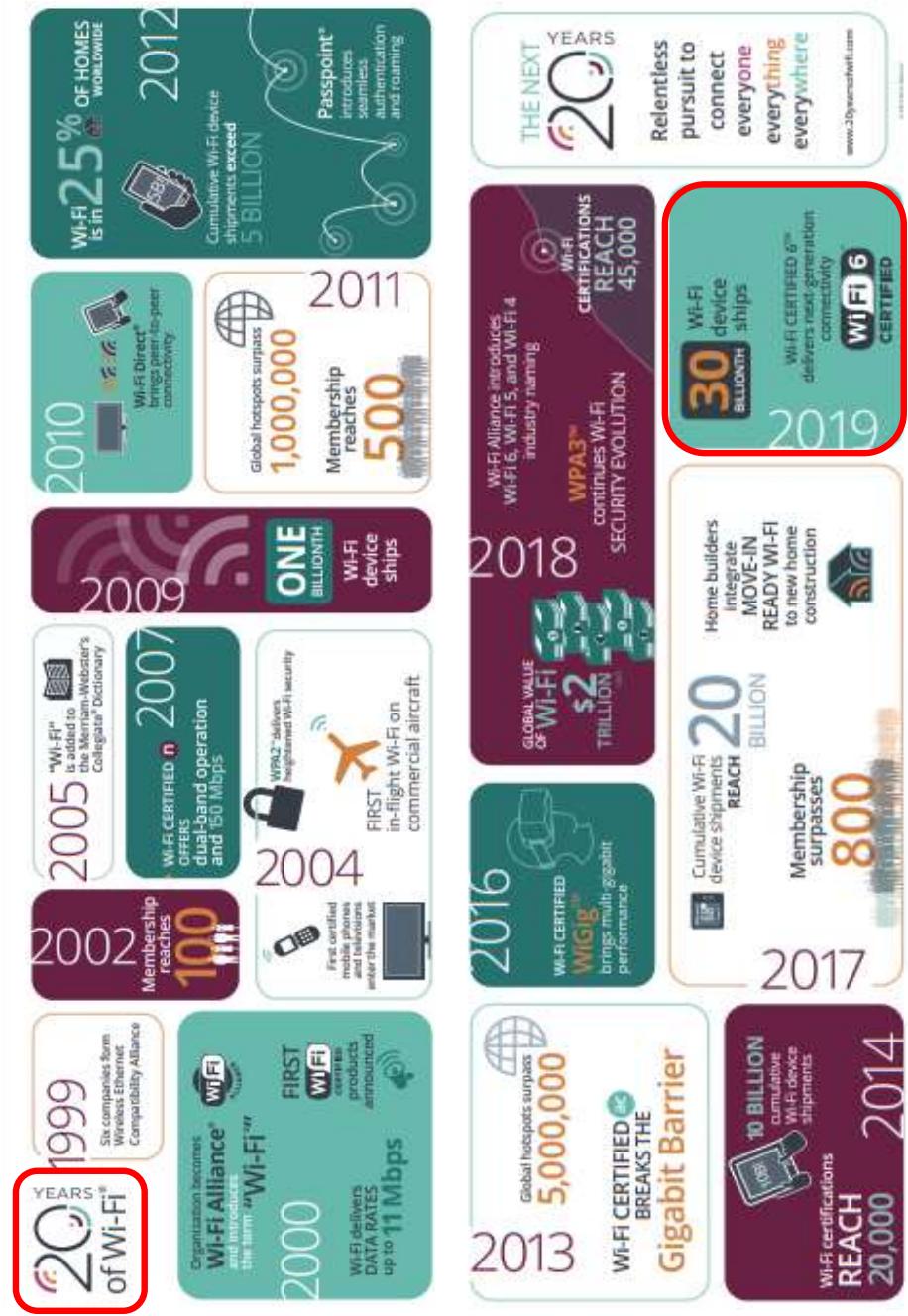
Wi-Fi Home Monitoring



Home Monitoring: WiFi Sensing Application Overview

<https://www.youtube.com/watch?v=jDUC5D3Wcv0&t=11s>

18



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<https://www.wi-fi.org/discover-wi-fi/20-years-of-wi-fi>



表1 Wi-Fi標準的變革與關鍵技術

Launch Date	IEEE Standard	Wi-Fi 4	Wi-Fi 5	Wi-Fi 6	Wi-Fi 7
	802.11n HT	802.11ac VHT	Very High Throughput	802.11ax High Efficiency	802.11be EHT Extremely High Throughput
2007	802.11n	802.11ac		2021	2024
2013		3.5Gbps			
2019		9.6Gbps			
					802.11be
					46Gbps
					1~7256Hz (including 2.4GHz, 5GHz, 6GHz bands)
Bands	2.4GHz and 5GHz	5GHz	2.4GHz and 5GHz	6GHz	WPA3
Security	WPA 2	WPA 2	WPA 3		
Channel size	20,40MHz	20,40, 80, 80+80, 160MHz	20,40, 80, 80+80, 160MHz	20,40,80,80+80, 160MHz	Up to 320MHz
Modulation	64-QAM OFDM	256-QAM OFDM	1024-QAM OFDMA	4096-QAM OFDMA (with extensions)	
MIMO	4x4 MIMO	4x4 MU-MIMO	8x8 UL/DL MU-MIMO	16x16 MU-MIMO	

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<https://www.2cm.com.tw/2cm/zh-tw/market/816E60695A034022BC4DD03D0602ACFA>

WiFi 6

- 資料傳輸率提高 (Data rate)
- 容量增加 (Capacity)
- 吞吐量增加 (Throughput)
 - 裝置聯網效能改善
 - 精能改善 (Power efficiency)



802.11ac → 802.11.ax



OFDMA

<https://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-introduces-wi-fi-6>

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關鍵技術

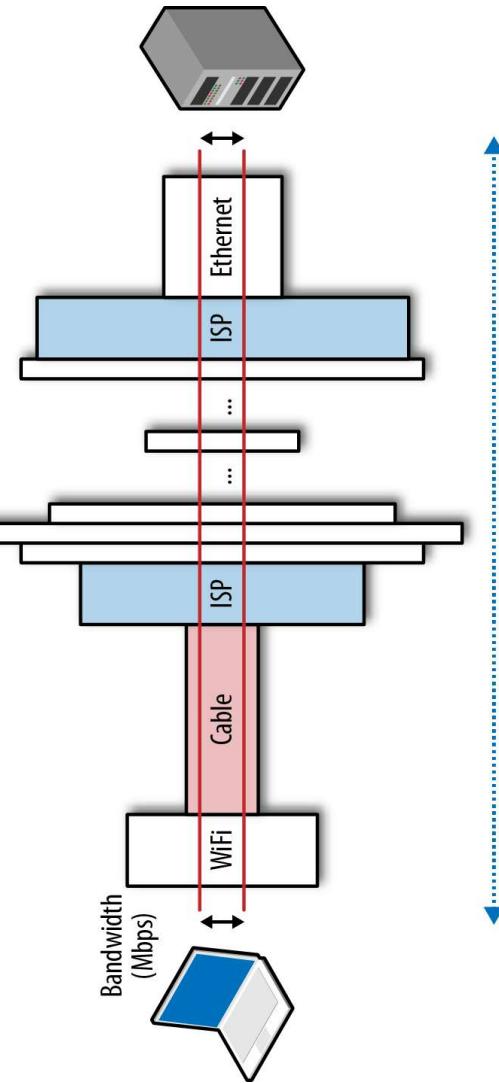


- OFDMA
- Multi-user
- 1024-QAM
- Target wake time

Low latency、Higher throughput、Higher data rate

22

- 延遲 (Latency)：一個封包從來源端送出後，到目的端接收到底個封包，中間所花的時間
- 頻寬 (Bandwidth)：傳輸媒介最大吞吐量 (Throughput)



23

<https://blog.gtwang.org/web-development/network-latency-and-bandwidth/>

Highway traffic

- Throughput
 - The number of vehicles passing through a particular point on the highway within a given time frame.
- Latency
 - The time it takes for a vehicle to travel from one point to another on the highway
- Bandwidth
 - The number of lanes on the highway

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Water pipeline

- Throughput
 - ??
- Latency
 - ??
- Bandwidth
 - ??

Conveyor belt system

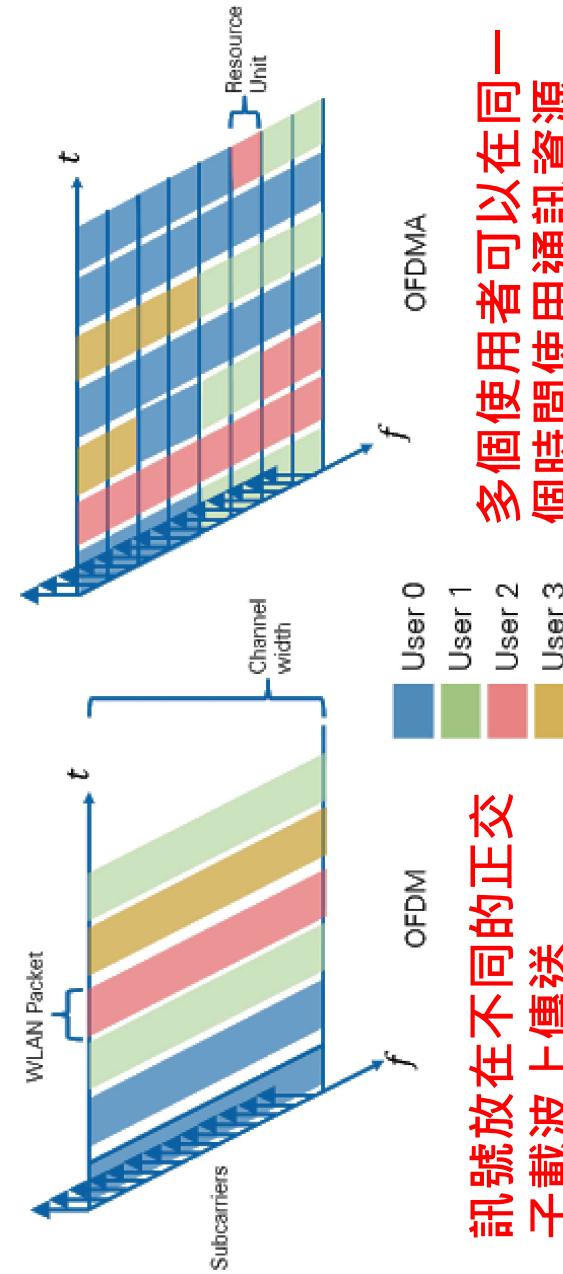
- Throughput
 - ??
- Latency
 - ??
- Bandwidth
 - ??

OFDMA

- **OFDMA** = OFDM + FDMA
 - OFDM: Orthogonal Frequency Division Modulation
 - FDMA: Frequency Division Multiple Access

Orthogonal Frequency Division Multiple Access 正交分頻多重存取

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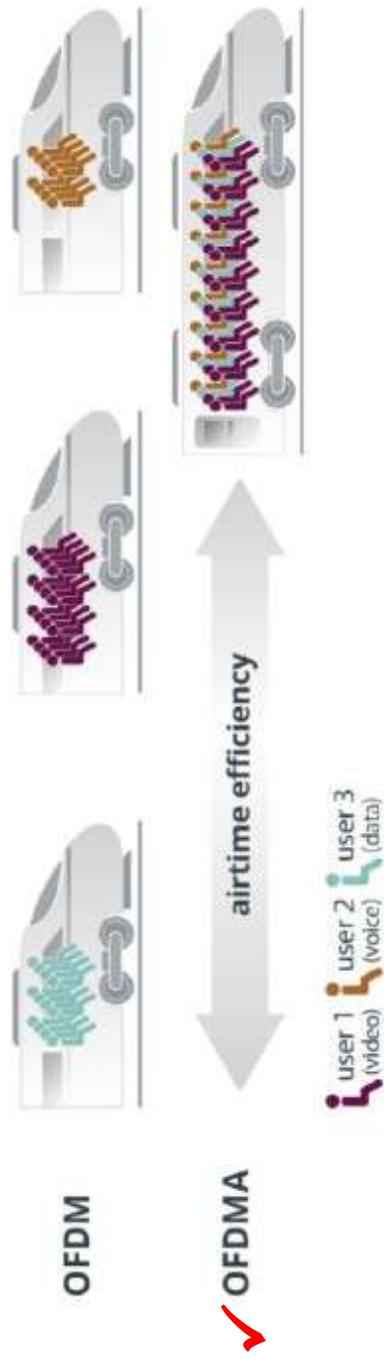
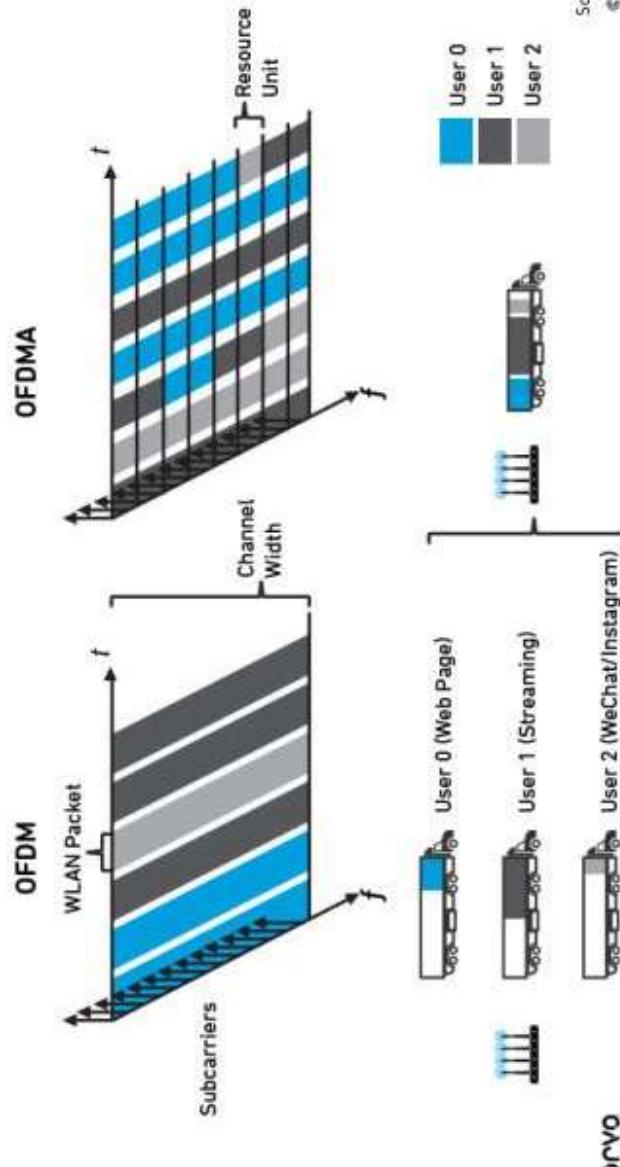


Figure 1. OFDMA in Wi-Fi 6 allows multiple users with different traffic profiles to transmit simultaneously over the same channel

妥善使用Bandwidth，降低Latency

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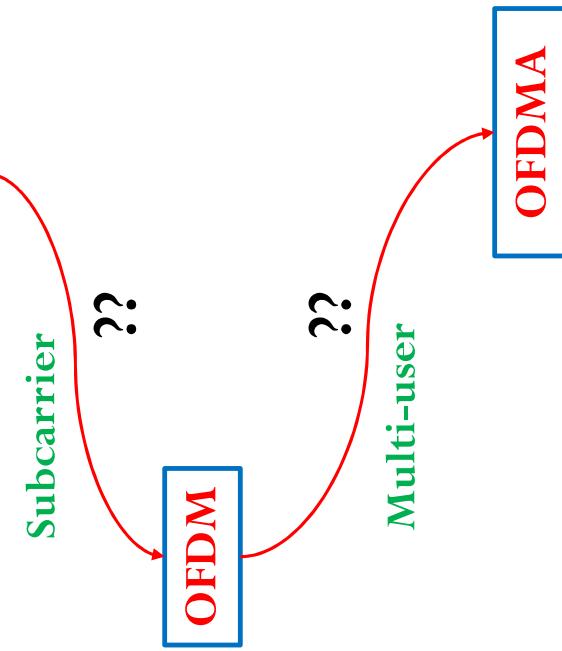
802.11ac vs. 802.11ax: Fixed Overhead vs. Efficient Payload Delivery



Source: Qualcomm
©2017 Qorvo, Inc.

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Spectrum



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MU-MIMO

Transmit to one device at a time in "round-robin" sequence

**單一用戶
依序循環**



Single-user MIMO

*Transmit to multiple devices simultaneously:
Up to 4x capacity with an advanced grouping and rate algorithm!*

**同時傳給
多個用戶**



Multi-user MIMO

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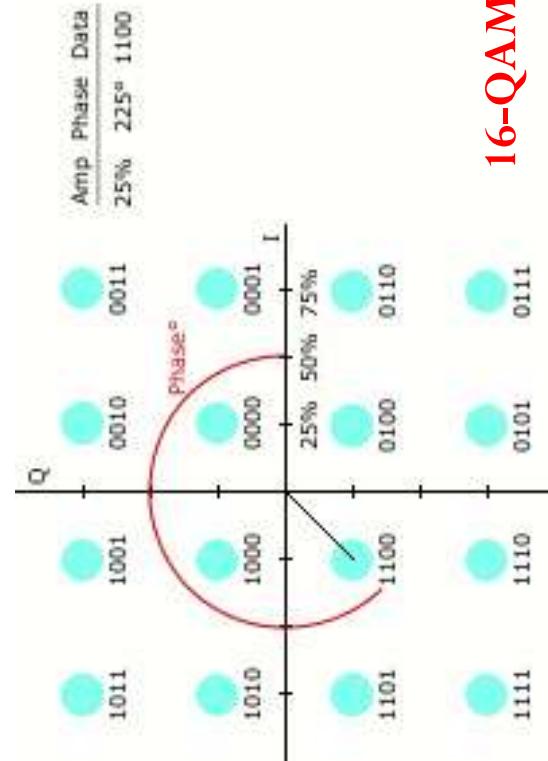
MU-MIMO Explained

<https://www.youtube.com/watch?v=B2lh8FohnwUs&t=14s>

33

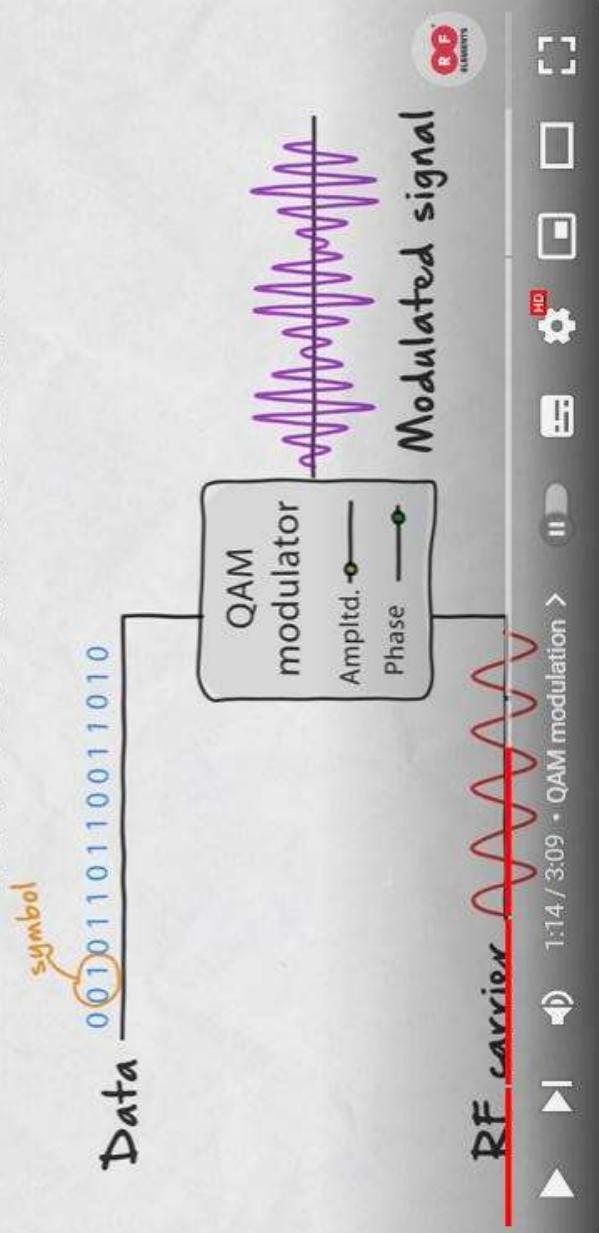
QAM

- 正交振幅調變
- Quadrature Amplitude Modulation
- 在兩個正交載波上進行振幅調變的調變方式



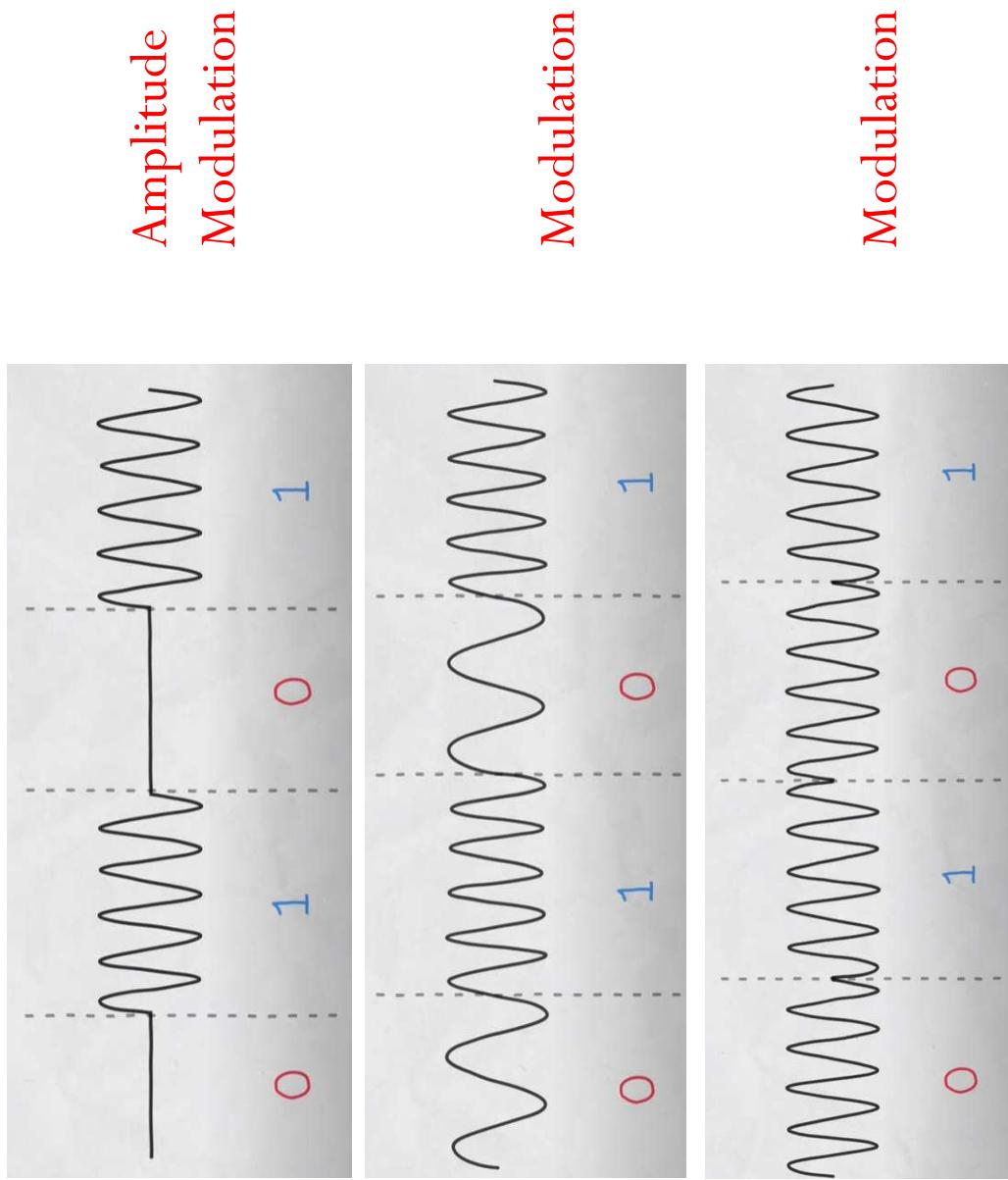
34

QAM MODULATOR SCHEME



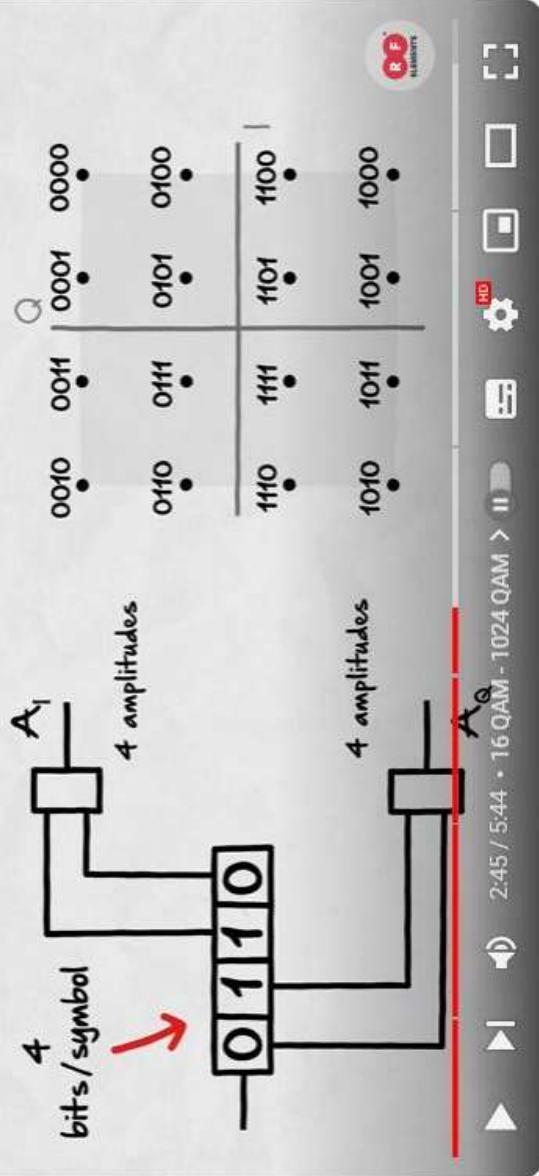
Inside Wireless: QAM modulation (Quadrature Amplitude Modulation)

35



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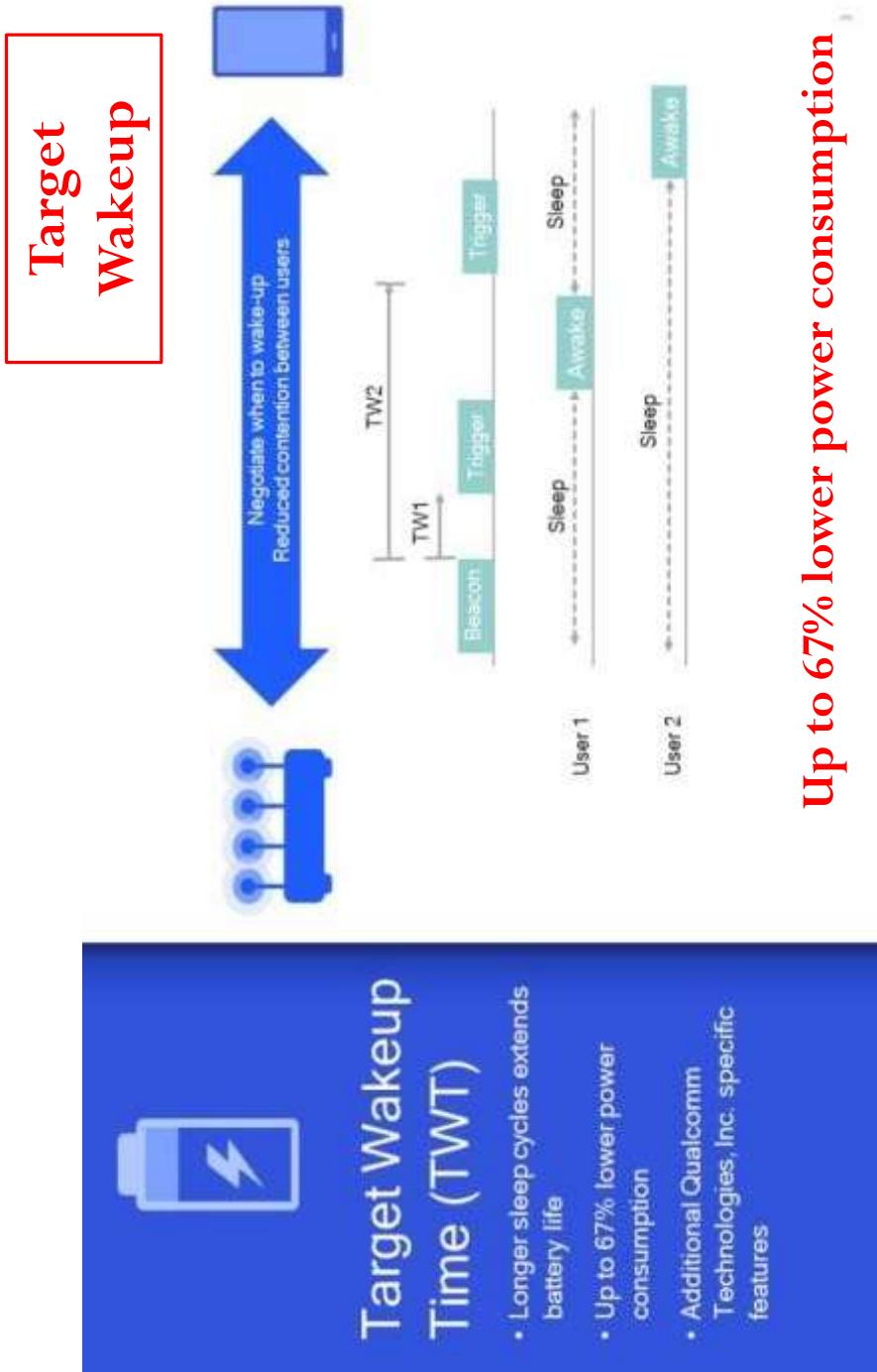
16 QAM



Inside Wireless: QAM modulation II - The Modulator

<https://www.youtube.com/watch?v=YnWCRUoTEAI>

37



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Up to 67% lower power consumption

WPA

Wi-Fi Protected Access

	WPA 2	WPA 3
Security	AES + CCMP	AES-192 bit + GCMP
Authentication	PSK	SAE
Protection	KRACK and brute-force attacks	WPA 2 + passphrase guessing
Configuration	Complex	Easy
Transition mode	Either WPA 2 or WPA 3 devices	Both WPA 2 and WPA 3 devices

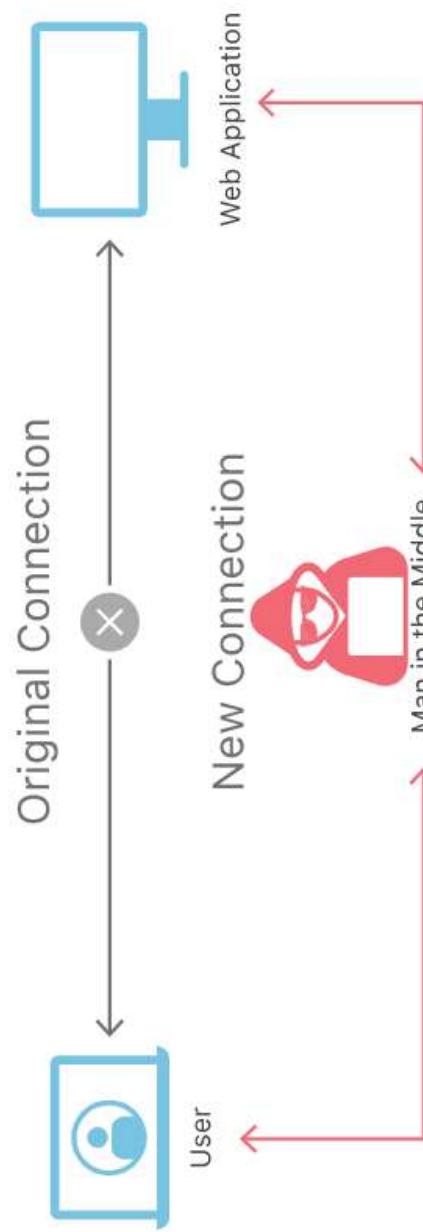
Encryption

- AES
- Advanced Encryption Standard
- CCMP
- Counter Mode Protection
- GCMP
- Galois/Counter Mode Protection
- PSK
 - Pre-Shared Key
- SAE
 - Simultaneous Authentication of Equals

- KRACK
 - Key Reinstallation Attack
 - Brute-force attacks
 - Systematically try all possible combinations of characters until the correct password or passphrase is found
 - Passphrase guessing
 - Guess or infer a user's passphrase by using **educated guesses**, exploiting patterns, or leveraging social engineering techniques

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KRACK



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<https://www.cloudflare.com/zh-tw/learning/security/what-is-a-krack-attack/>

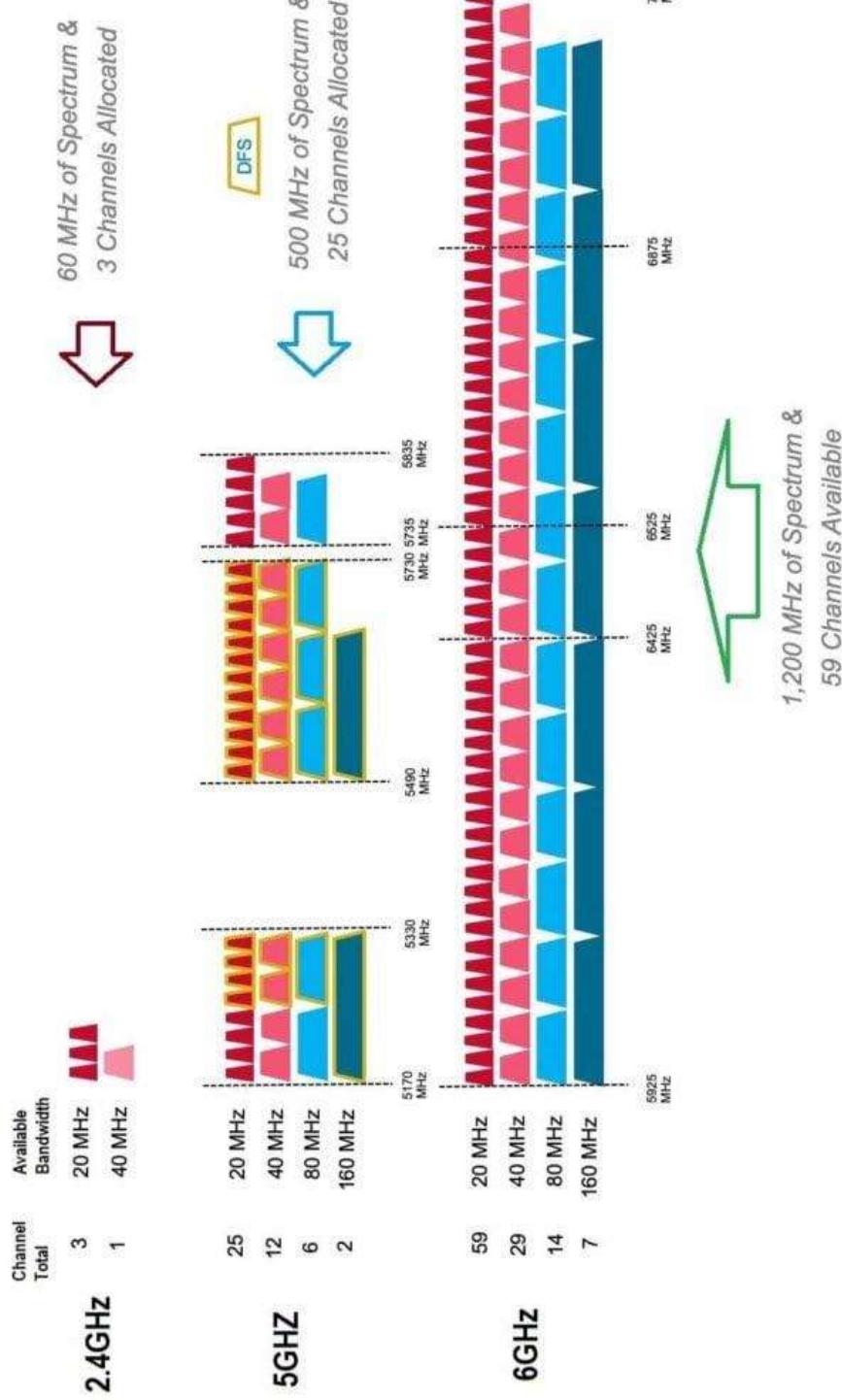
HOW A BASIC BRUTE FORCE ATTACK WORKS



<https://www.cloud4u.com/blog/what-is-brute-force/>

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Wi-Fi Frequency Bands



Highway traffic

- Band
 - ??
- Channel
 - ??
- Channel size
 - ??

45



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什麼是 Wi-Fi 7 ? 最新 Wi-Fi 標準 - Wi-Fi 7 完整介紹 | TP-Link
<https://www.youtube.com/watch?v=vYvMnPMhYU&t=64s>

Bluetooth

Bluetooth Version	Introduction	Data Rate	Range	Key Features
Bluetooth 1.x	Late 1990s	Up to 1 Mbps	Up to 10 meters (33 ft)	Basic data transmission, wireless audio, file transfer
Bluetooth 2.0	Early 2000s	Up to 3 Mbps	Up to 10 meters (33 ft)	Enhanced Data Rate (EDR), improved pairing
Bluetooth 3.0	2009	Up to 24 Mbps	Up to 10 meters (33 ft)	High-Speed Bluetooth, HS-Bluetooth
Bluetooth 4.0	2010	Up to 1 Mbps (Classic), 0.27 to 1 Mbps (BLE)	Up to 10 meters (33 ft) for Classic Bluetooth, up to 100 meters (330 ft) for BLE	Introduction of Bluetooth Low Energy (BLE), energy-efficient communication, suitable for IoT devices
Bluetooth 5.0	2016	Up to 2 Mbps	Up to 40 meters (131 ft) indoors, up to 240 meters (800 ft) outdoors	Significant improvements in speed, range, and reliability, enhanced support for IoT devices

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Bluetooth 5, 5.2, 5.3 Summary

	Released In	Transfer Speed	Range	Distinct Features
<u>Bluetooth 5</u>	July 2016	50 MB/s	200 m	Improved range, speed, and stability. Support for multiple simultaneous connections
<u>Bluetooth 5.2</u>	December 2019	50 MB/s	200 m	EATT, ISOC, and LE Audio
<u>Bluetooth 5.3</u>	July 2021	50 MB/s	200 m	Periodic Advertising Enhancement, Encryption Key Size Control Enhancements, Connection Sub Rating, and Channel Classification Enhancement



Bluetooth 藍芽的發明

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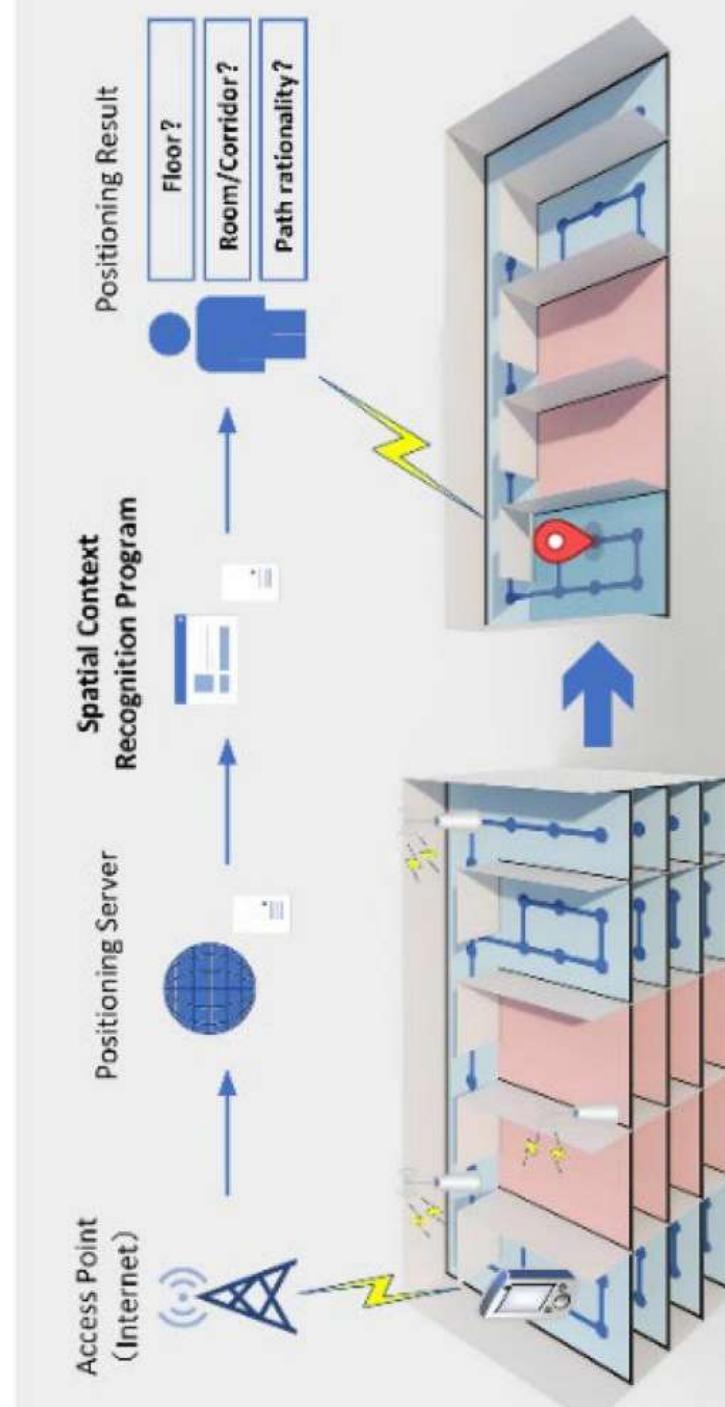
https://www.youtube.com/watch?v=scP_V8LJM0I

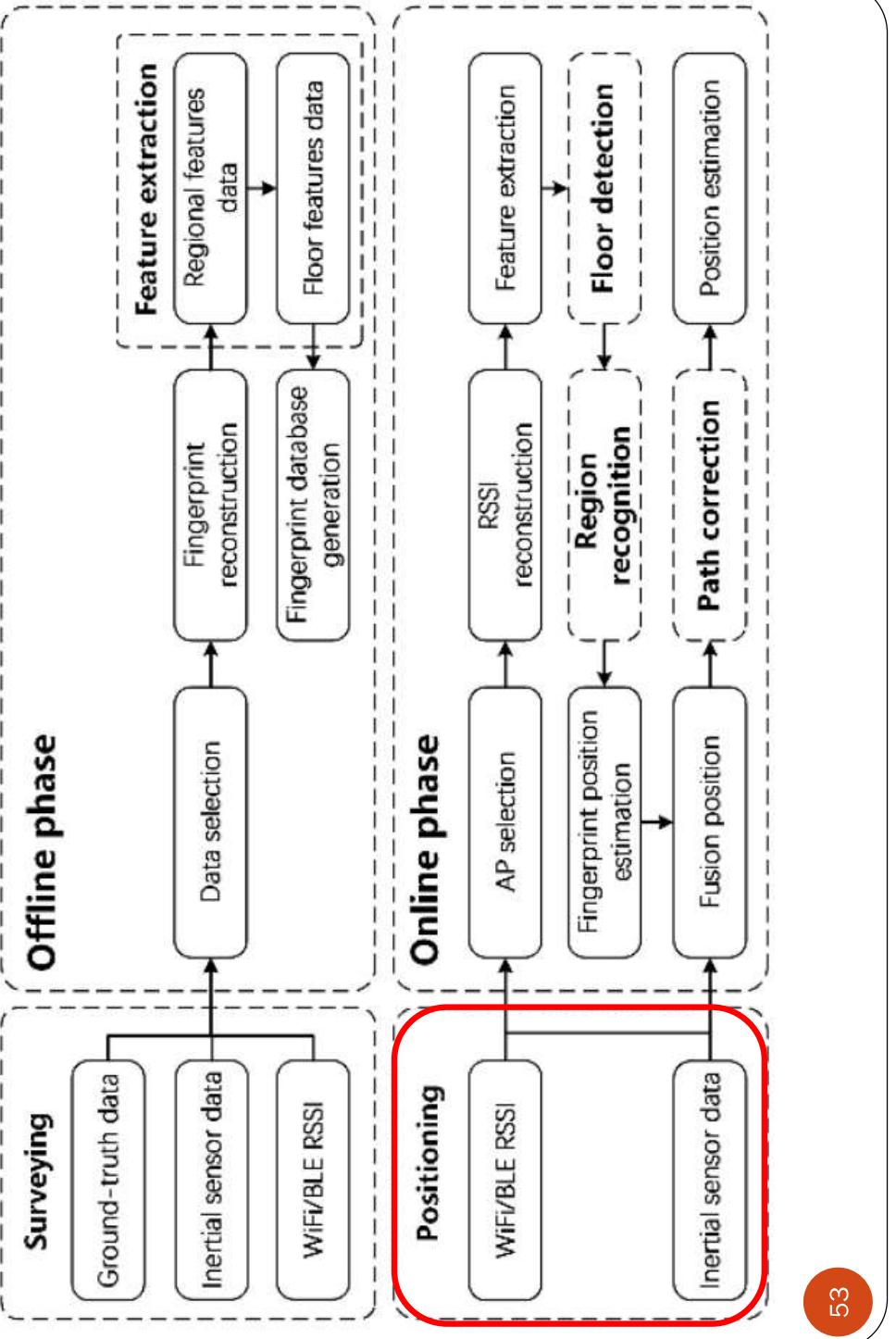
Feature	Bluetooth 5	Wi-Fi 6
Frequency Band	2.4 GHz, 5 GHz	2.4 GHz, 5 GHz
Range	Up to 40 meters (131 feet) indoors, up to 240 meters (800 feet) outdoors	Varies depending on environment and equipment
Data Rate	Up to 2 Mbps	Up to 96 Gbps
Use Cases	Short-range communication, IoT devices	High-speed wireless networking
Interference	May experience interference in crowded environments	Features to mitigate interference and improve coexistence
Power Consumption	Optimized for low-power operation	More power-efficient compared to previous standards, but may consume more power than Bluetooth 5
Applications	Wireless audio streaming, IoT devices	4K video streaming, online gaming, large file transfers

An Enhanced Indoor Positioning Solution Using Dynamic Radio Fingerprinting Spatial Context Recognition

Xiaodong Gong^D, Jingbin Liu^D, Sheng Yang^D, Fuqiang Gu^D, Member, IEEE, Gege Huang^D, and Yu Bai

The experimental results show that the **floor detection accuracy** reached 99% while **region recognition accuracy** reached 90.75%.





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TABLE I
EVALUATION OF POSITION SOLUTIONS ON DIFFERENT FLOORS IN WUEB

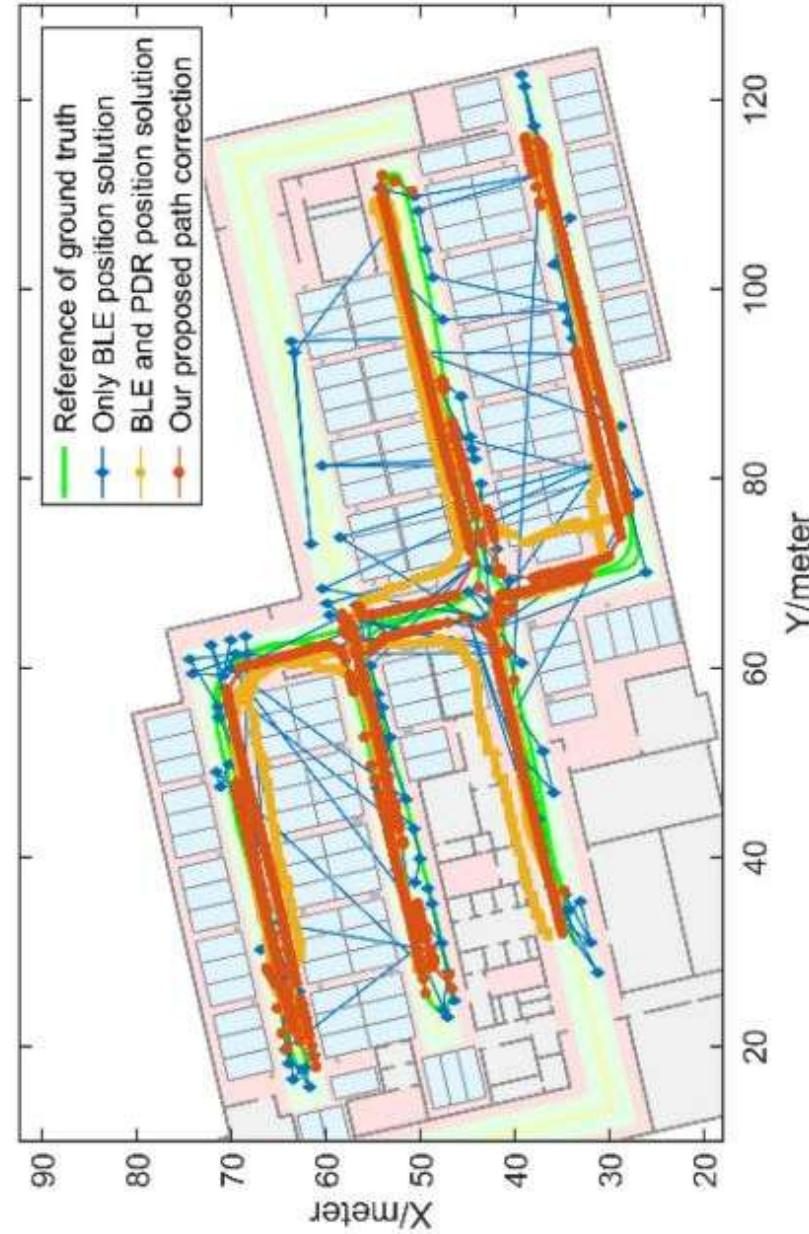
Floor no.	WiFi(%)	BLE(%)	WiFi+ BLE(%)	Atrium
1	96.99	99.50	100.00	Y
2	99.00	99.50	99.01	Y
3	99.00	99.50	99.00	N
4	99.00	98.50	99.01	N
5	99.50	99.50	99.00	N
Average	98.70	99.30	99.20	

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TABLE III
EVALUATION OF DIFFERENT POSITION SOLUTIONS IN WUEB

Position solution	Fingerprinting region accuracy (%)	Non-fingerprinting region accuracy (%)	Average accuracy (%)
WiFi	93.00	58.00	75.50
BLE	100.00	69.00	84.50
WiFi+ BLE	93.00	88.50	90.75

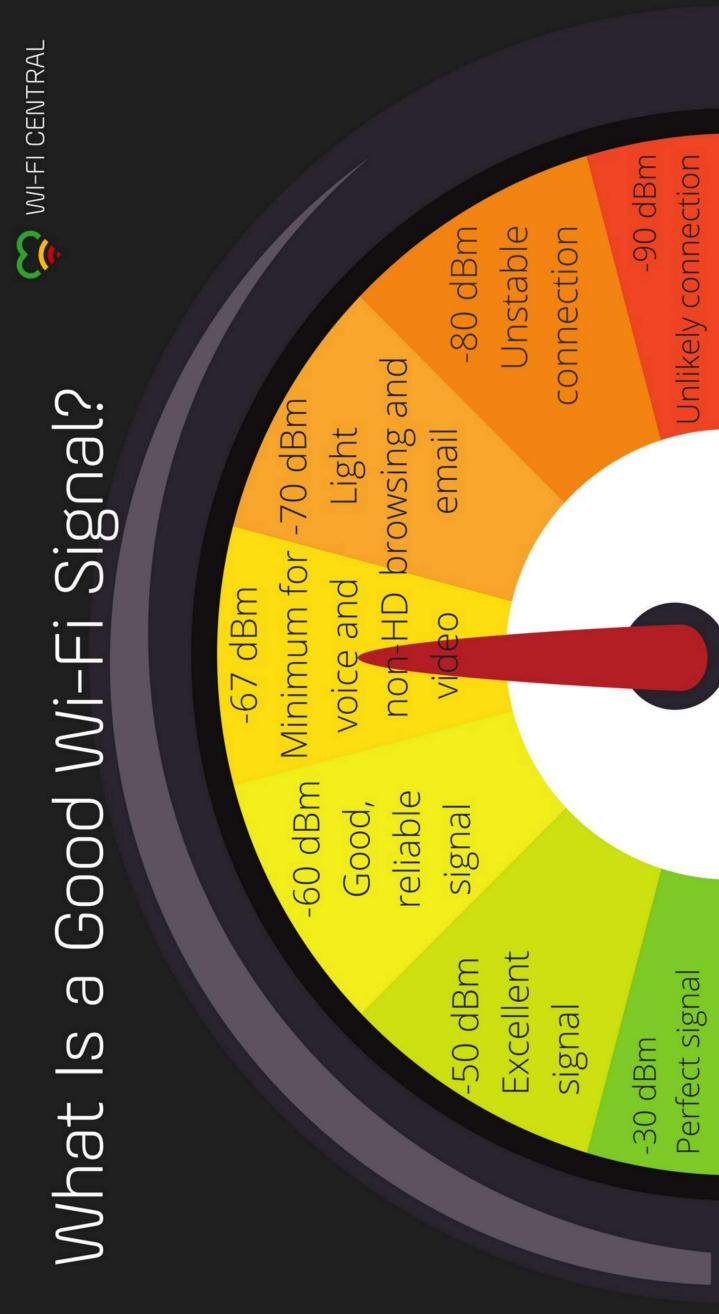
55



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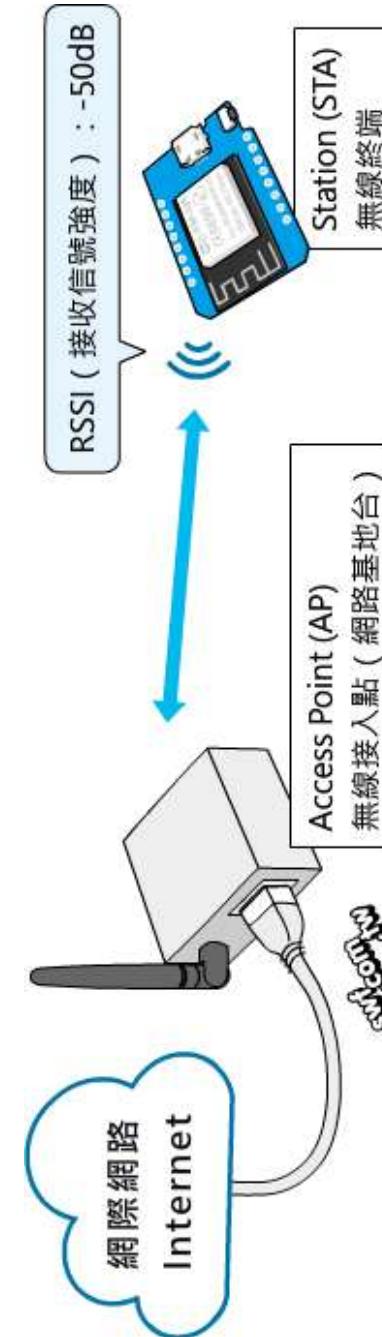
RSSI

Received Signal Strength Indicator



<https://eyenetworks.no/en/required-good-wifi-signal-strength/>

57



<https://swf.com.tw/?p=1161>

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```

WiFi.begin(ssid, password);
Serial.print("Connecting Wi-Fi");

while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
}

#include <ESP8266WiFi.h>

// Wi-Fi基地台的名稱和密碼
const char* ssid = "無線網路AP名稱";
const char* password = "無線網路密碼";

unsigned long previousMillis = 0;
const long interval = 2000;

void setup(void) {
    Serial.begin(9600);
}

WiFi.mode(WIFI_STA);
delay(100);

void loop(void) {
    unsigned long currentMillis = millis();

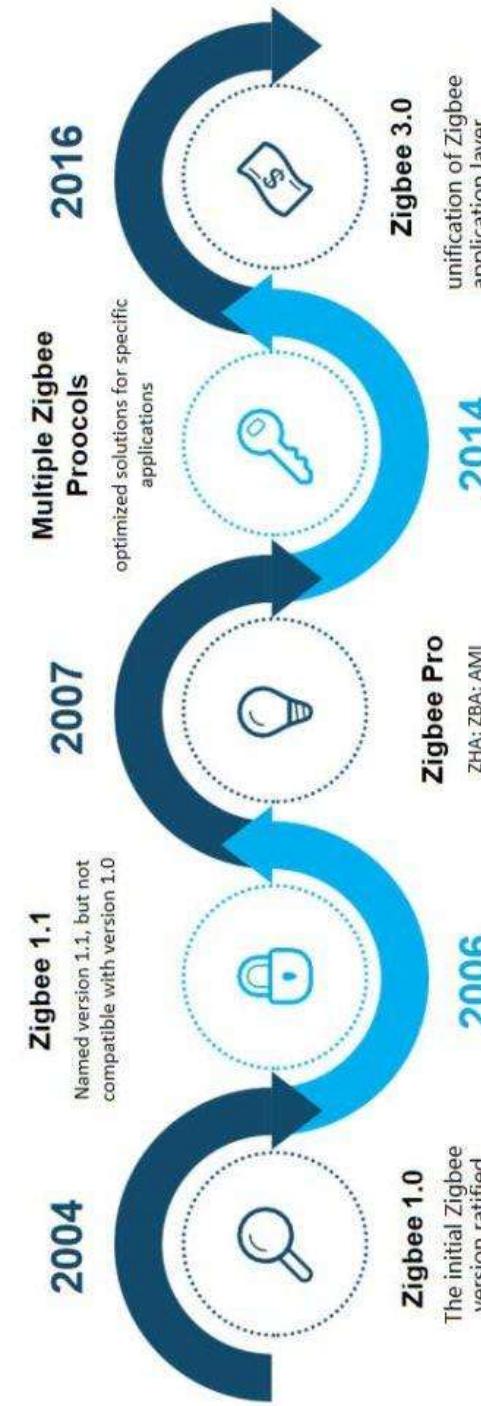
    if (currentMillis - previousMillis >= interval) {
        previousMillis = currentMillis;
        // 讀取RSSI數值
        int rssi = WiFi.RSSI();

        Serial.print("RSSI: ");
        Serial.println(rssi);
    }
}

```

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Zigbee



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不只是Zigbee智慧插座，
還是Zigbee信號中繼站。



<https://vizo.com.tw/product/zigbee%E6%99%BA%E6%85%85%A7%8F%92%E5%BA%A7/>



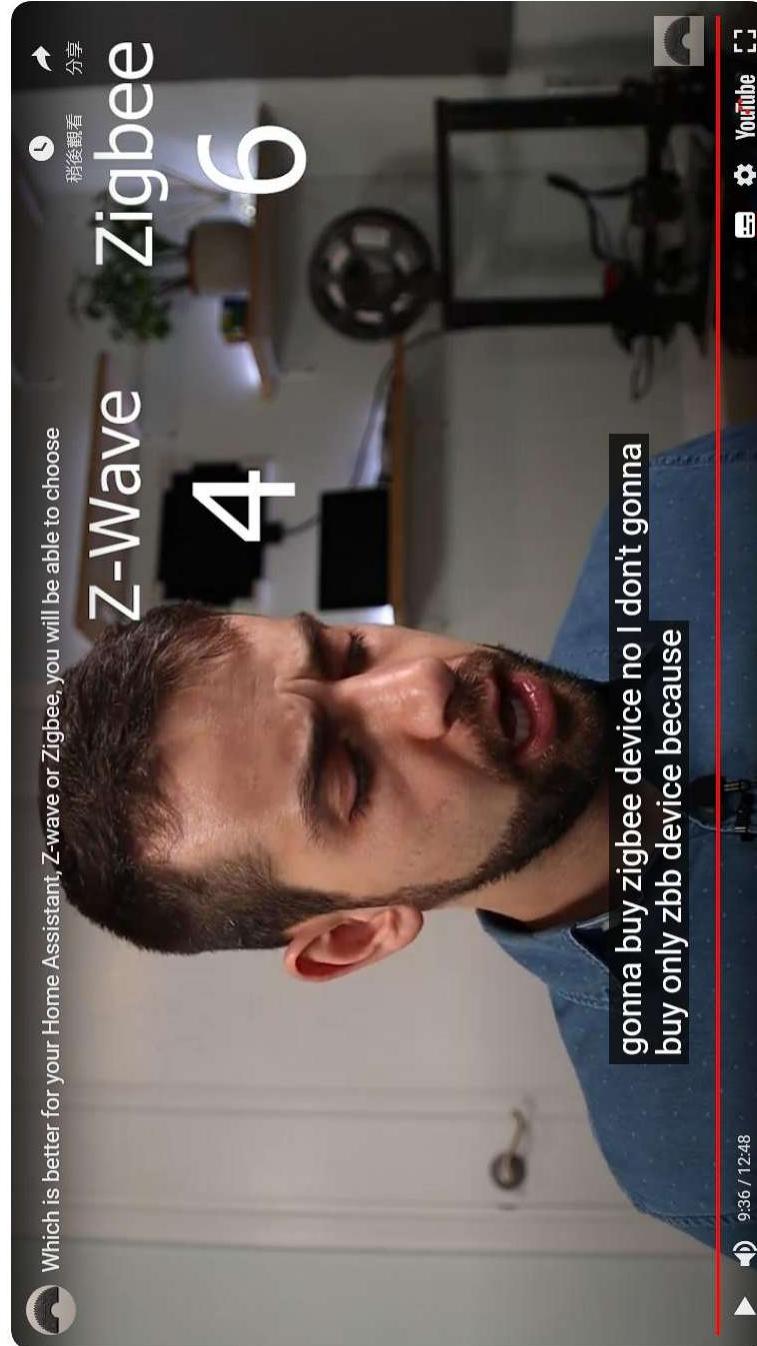
《Wow!CASA》藍牙、WIFI、Zigbee誰更適合物聯網，各有哪些優缺點？

<https://www.youtube.com/watch?v=7DC1Pqgb-Ys&t=24s>

Zigbee vs Z-wave

Feature	Zigbee	Z-Wave
Frequency Band	2.4 GHz	Sub-1 GHz (typically around 900 MHz)
Topology	Mesh network topology	Mesh network topology
Range	Up to 10-20 meters indoors	Up to 30 meters indoors, up to 100 meters outdoors
Interoperability	Better interoperability between devices from different manufacturers	Devices must be certified for compatibility
Data Rate	Up to 250 kbps	Up to 100 kbps
Power Consumption	Generally consumes less power	Generally consumes more power
Applications	Home automation, smart lighting, industrial control systems	Home automation, security systems, energy management

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<https://www.youtube.com/watch?v=CRkGDWaTLGs&t=578s>



When Is Wi-Fi NOT The Answer? - Zigbee and Z-Wave

<https://www.youtube.com/watch?v=p4vZb-prIt0&t=14s>

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ZigBee devices

Discover our Zigbee products, one of the main communication standards used in the world of wireless technologies.

With a single ZigBee central unit, you can easily combine a variety of products and manage them conveniently and interactively from your mobile or tablet.

There are 46 products.

Sort by:

Relevance

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grid

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- €0.50

Reduced price
- €0.50

Reduced price
- €1.00

Reduced price
- €1.00

BRAND: SONOFF TECH
SONOFF SNZB-02

★★★★★ 14 reviews

ZigBee Temperature and Humidity Sensor

€8.49 €8.99

Add to cart ✓ In stock

BRAND: SONOFF TECH
SONOFF SNZB-03

★★★★★ 7 reviews

ZigBee Motion Sensor

€9.49 €12.99

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BRAND: SONOFF TECH
SONOFF SNZB-04

★★★★★ 14 reviews

ZigBee alarm sensor for doors and windows

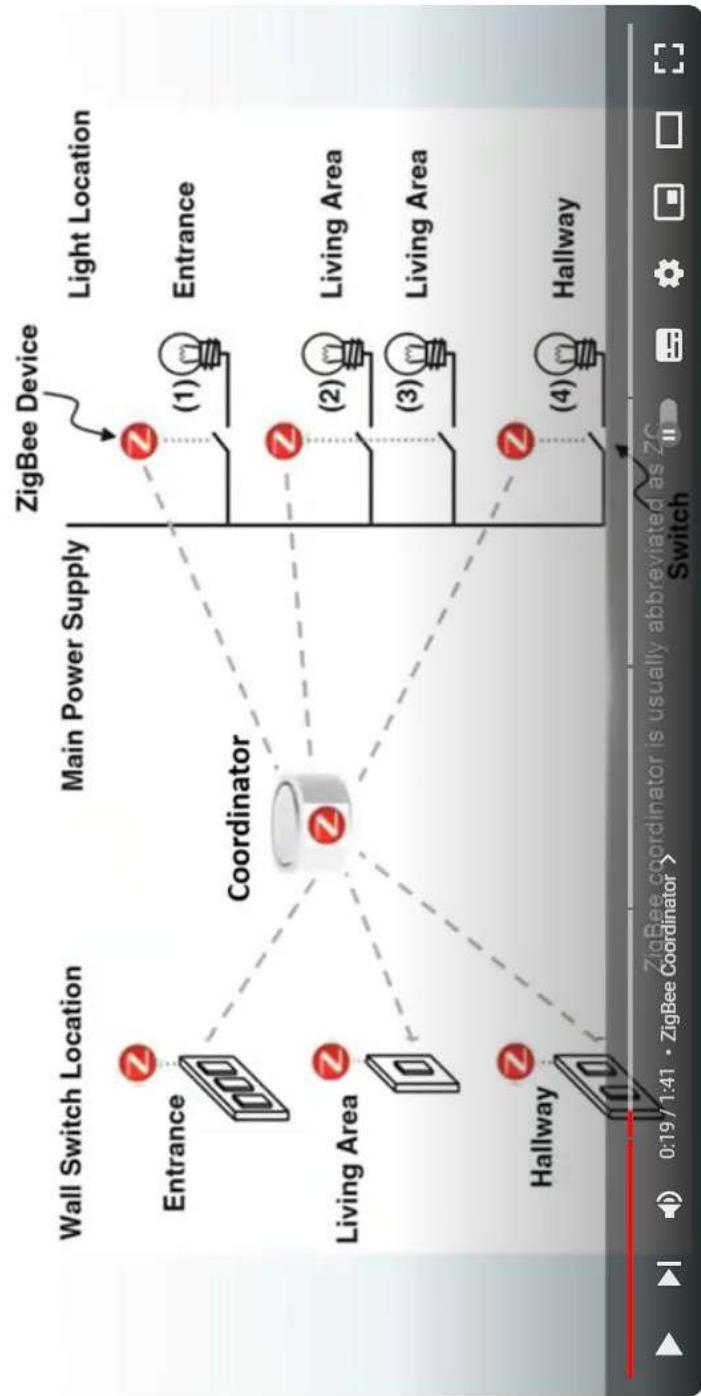
€7.98 €8.99

Add to cart ✓ In stock

<https://www.expert4house.com/en/zigbee-devices>

66

Home Automation



Typical Applications of ZigBee Module Networking in the Field of IoT (1)

<https://www.youtube.com/watch?v=9hzaEtZ7Z70&t=59s>

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Learn Products Guides Support Blog Q



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<https://www.z-wave.com/shop-z-wave-smart-home-products>



Z-Wave Smart Locks - HD

https://www.youtube.com/watch?v=Cz_y15z1TEg&t=3s

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作業

- 請綜整 Wi-Fi 、 Bluetooth 、 Zigbee 、 Z-wave 等的特性及優缺點
- 頻段
- 安全性
- 傳輸速率
- 傳輸距離
- 網路拓樸
- 應用領域
-

- 請自己找資料，千萬不要抄襲同學的答案！
- 建議答案儘量結構化，易讀、易了解內涵
- 內容以一張 A4 為限，字體：12 號字/標楷/Times New Roman
- 請助教挑選最優的 5 位同學答案，分享給所有同學參考。

作業

- 觀察p.72的影片
- 試比較WiFi, Zigbee, Z-Wave在智慧家庭應用上，個別的優缺點及較佳的應用情境

71

WiFi vs ZigBee vs Z-Wave: Which is Best for Your Smart Home?



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<https://www.youtube.com/watch?v=SAtDEdJbYZM&t=28s>

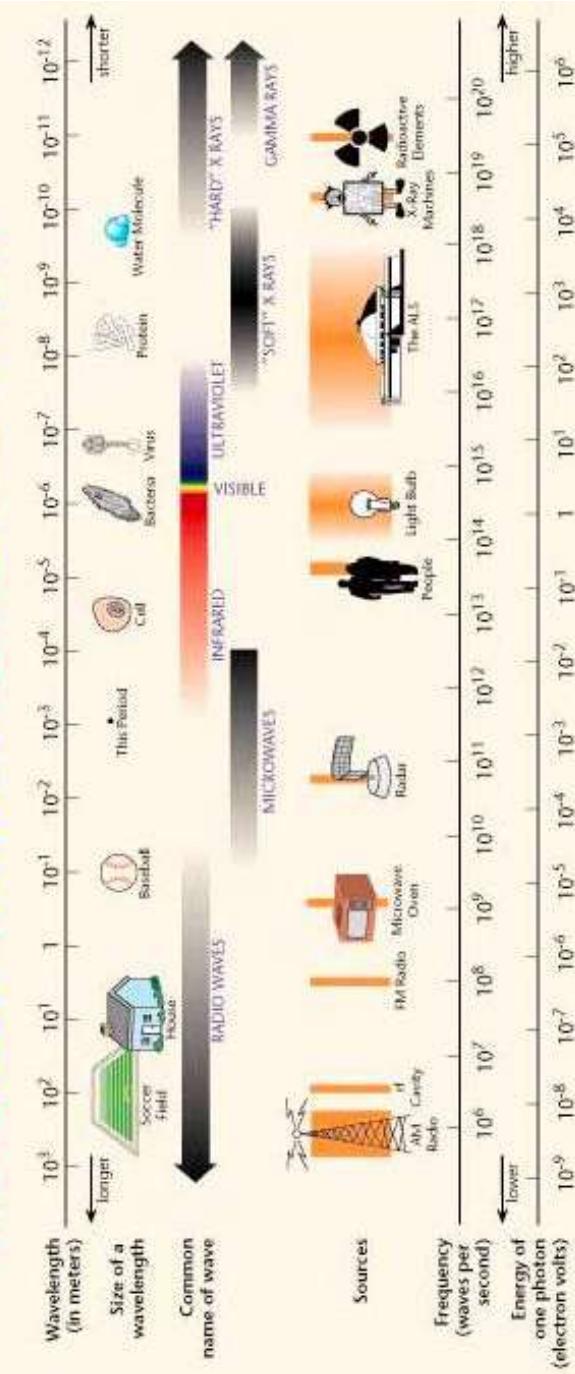


頻率、波長、傳輸距離、傳輸速率之間的關係？

<https://lknews.cc/zh-tw/news/y5z5kmg.html>

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THE ELECTROMAGNETIC SPECTRUM



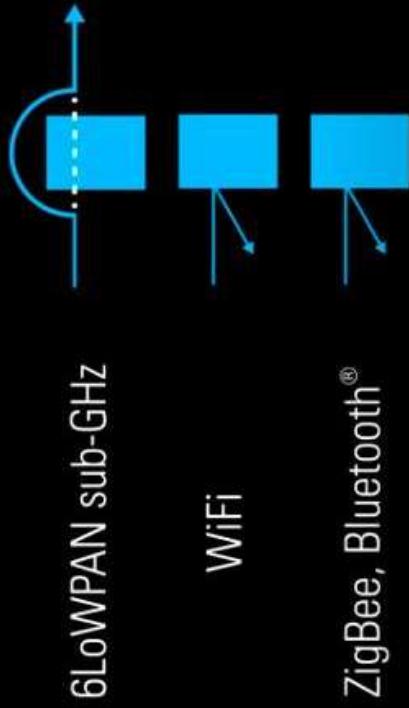
波長大→繞射能力強→傳輸距離遠→信號覆蓋廣
波長短→直射能力強→貫穿能力強→信號局部覆蓋

<https://www.wisewander.com/zhs/>

hk//%E4%BC%BD%9%A9%AC%E5%BD%84%E7%BA%BF

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Wireless Protocol Options for Mesh Networking



Compared to 2.4 GHz protocols, 6LoWPAN is the superior choice for extending signal range beyond obstructions such as walls and objects



<https://www.youtube.com/watch?v=qqwLAbUgfH4>

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Amazon

Amazon Echo

Alexa

Apple

Apple HomeKit

Siri

Google

Google Home

Google Assistant

智慧家庭 → 智慧助理

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智慧家庭平台	Apple HomeKit	Google Home	Amazon Alexa
支援手機用戶	僅iOS系統	Android, iOS系統皆可	Android, iOS系統皆可
支援的智慧音箱	HomePod	Google Home系列 Google Nest系列	Amazon Echo系列
手機觸控	中文介面 ✓	中文介面 ✓	沒有中文介面
	"家庭" App	Google Home App	Amazon Alexa App
手機聲控	支援中文 ✓ 內建Siri	支援中文 ✓ Assistant App	不支援中文 Amazon Alexa App
智慧音箱聲控	支援中文 ✓	支援中文 ✓	不支援中文 Alexa
語音助理	Siri	Google Assistant	Alexa

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哇!CASA

Google assistant 與 Apple Siri到底哪個好?



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<https://www.youtube.com/watch?v=55PuIV4zsX4>

Project Connected Home over IP



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SOFTWARE DEVELOPMENT BLOGS HARDWARE ENGINEERING

What You Need to Know About Project Connected Home Over IP

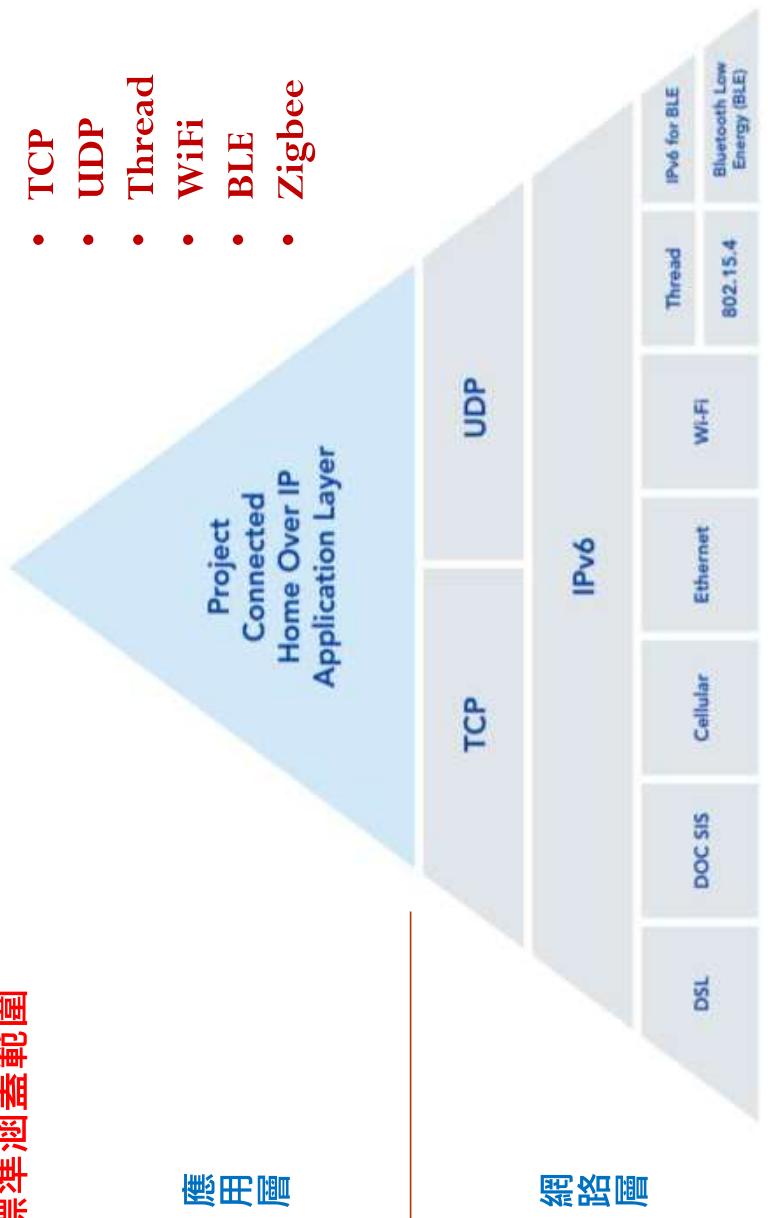
10 December 2020
By Jacob Arellano

<https://www.verypossible.com/insights/what-you-need-to-know-about-project-connected-home-over-ip>

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Project Connected Home over IP 技術標準涵蓋範圍

- TCP
- UDP
- Thread
- WiFi
- BLE
- Zigbee

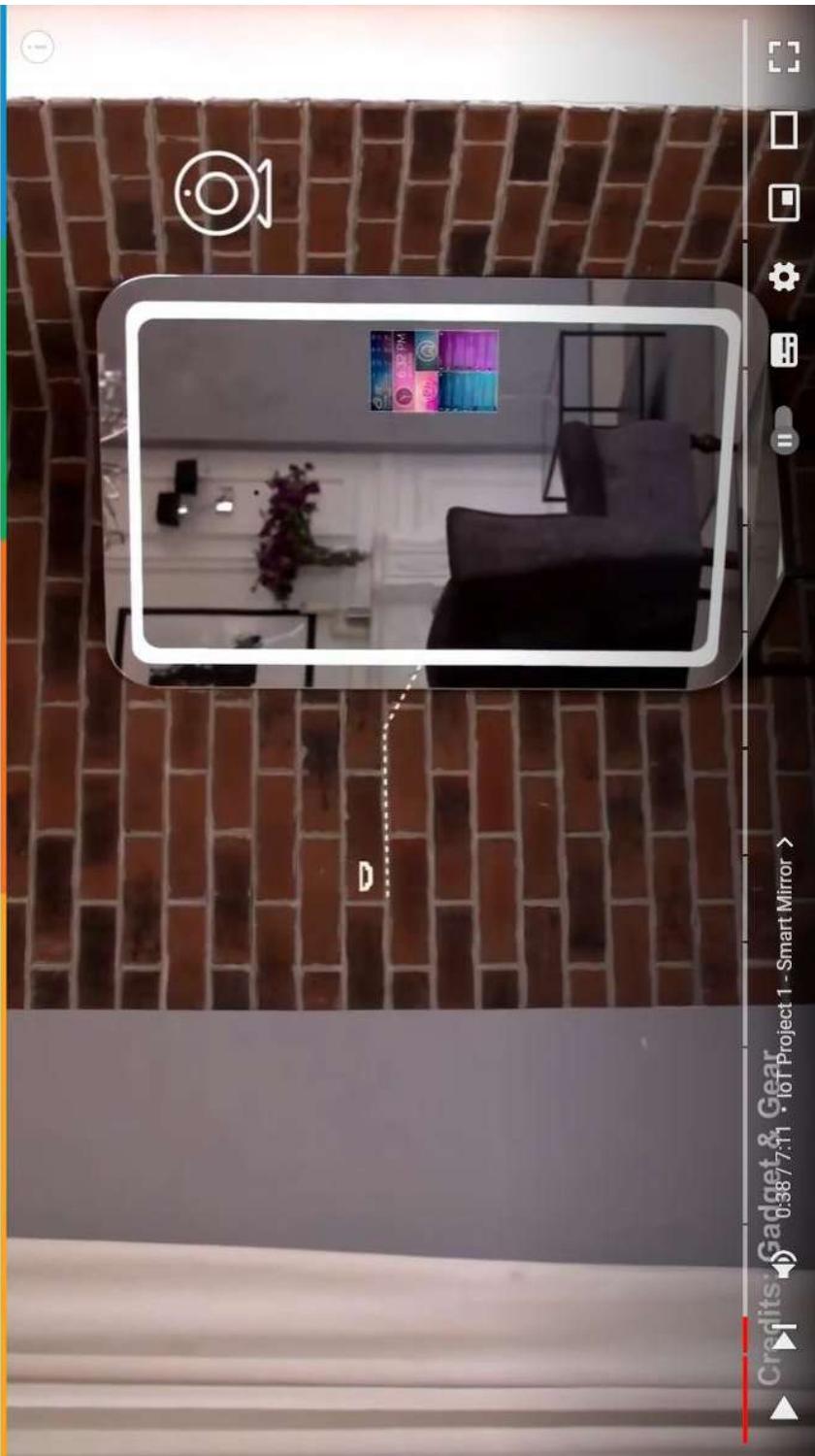


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作業

- 請觀看 p.83 影片：
- 依據你個人喜好，請將 10 種可能 IoT 應用排序；1：最
佳，2：次之，以下類推；
- 請簡述上題排序第一的應用情境。

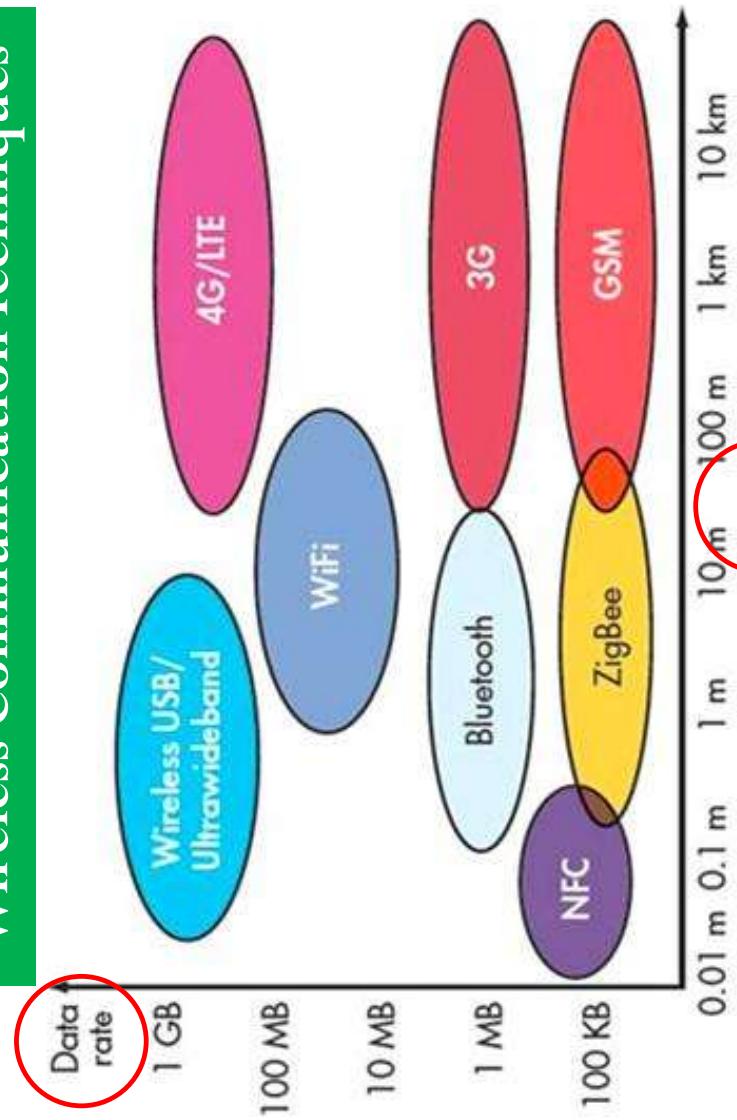
82



83

https://www.youtube.com/watch?v=N_z4OaSuoAA&t=1s

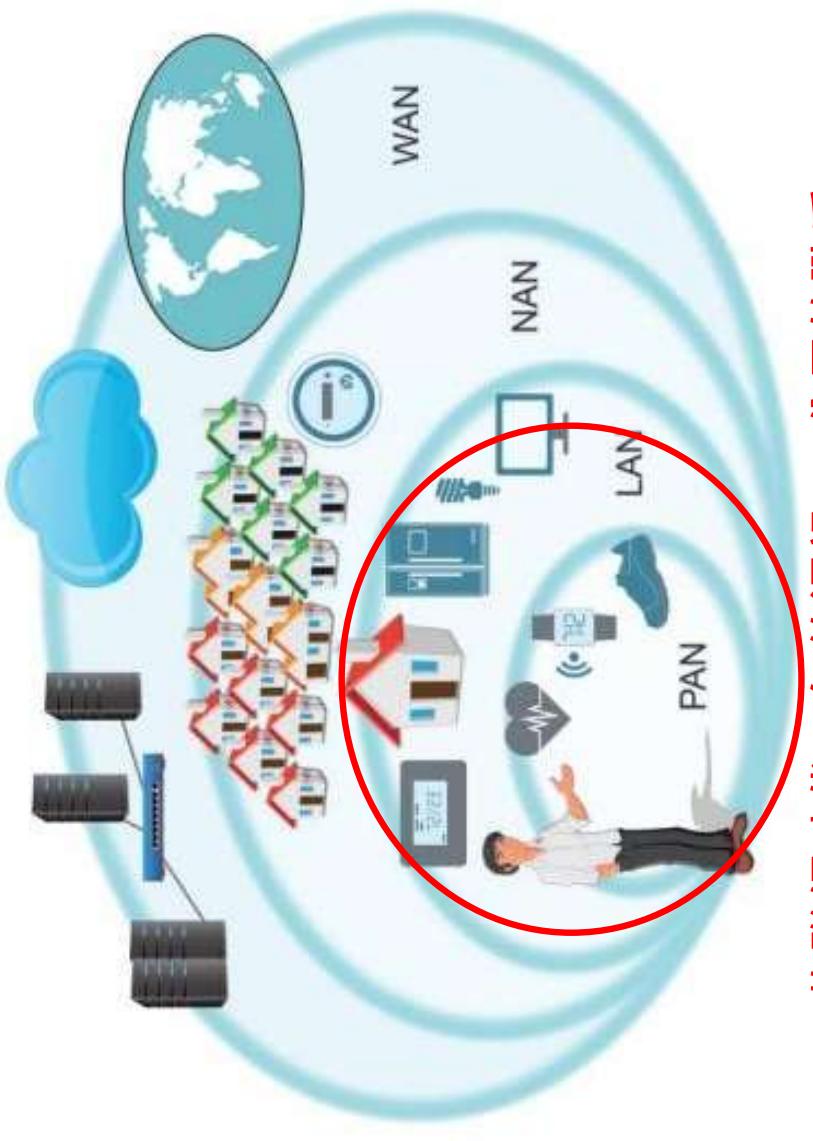
Wireless Communication Techniques



Data rate

http://www.naipo.com/Portals/1/web_tw/Knowledge_Center/Research_Development/publish-89.htm

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物聯網時代，無線通訊100公尺的戰爭

<http://technews.tw/2014/11/10/internet-of-things-age-wireless-communication-war/>

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- **PAN 個人區域網路**
 - Personal **A**rea **N**etwork
 - Bluetooth, IrDA, NFC, ...
- **LAN 區域網路**
 - Local **A**rea **N**etwork
 - Ethernet LAN (Wire/Wireless)
- **NAN 鄰近區域網路**
 - Neighborhood **A**rea **N**etwork
 - 2 or more LANs
- **WAN 廣域網路**
 - Wide **A**rea **N**etwork
 - Internet

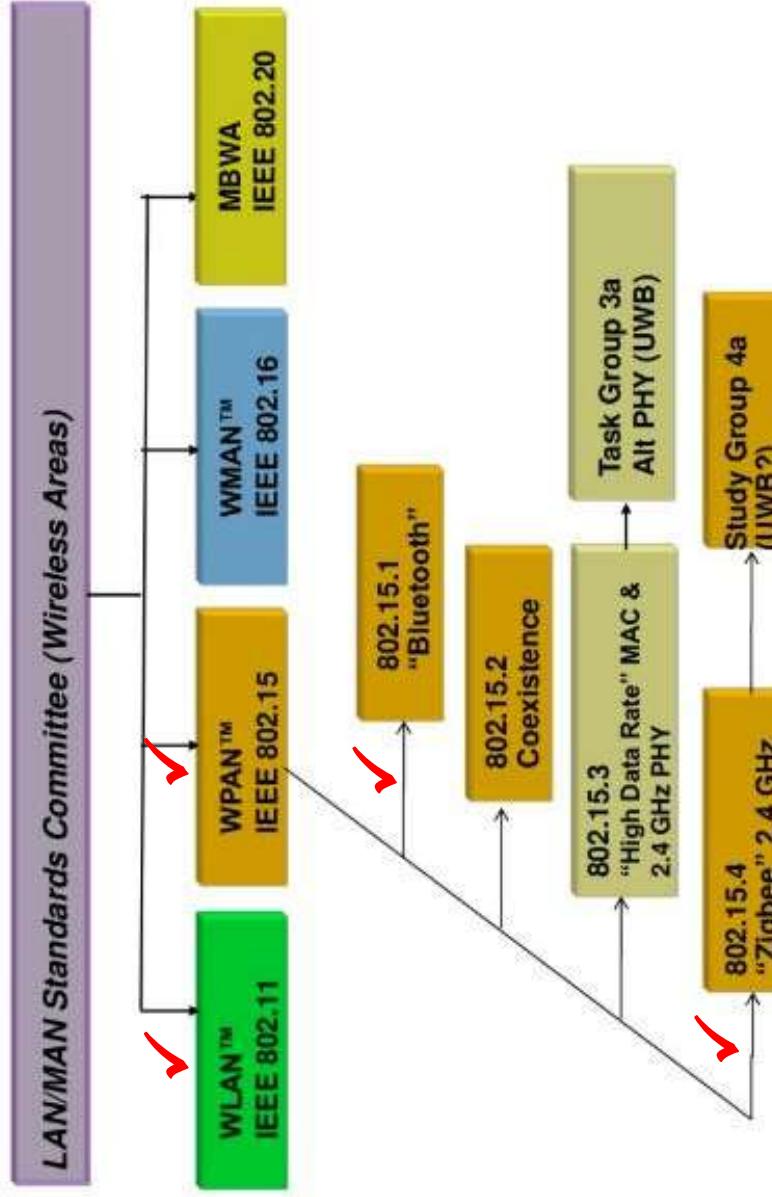
IEEE Standard

- IEEE
 - Institute of Electrical and Electronics Engineers
- IEEE 802.11 https://zh.wikipedia.org/wiki/IEEE_802.11
- Wireless Local Area Network
- IEEE 802.15 https://en.wikipedia.org/wiki/IEEE_802.15
 - Personal Area Network
 - Body Area Network
 - ...

802.11xx ` 802.15.x

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IEEE 802 Organization



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常見的藍牙模組

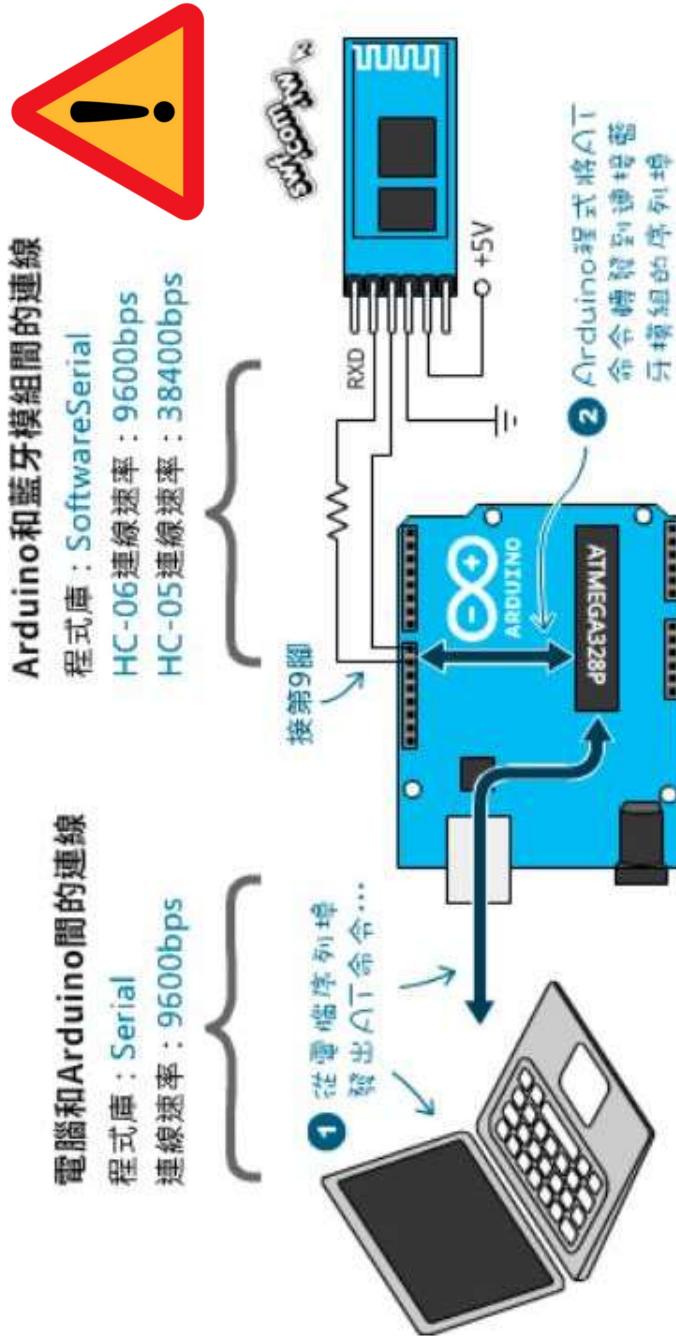
電腦和Arduino間的連線

程式庫：**Serial**
連線速率：**9600bps**

Arduino和藍牙模組間的連線

程式庫：**SoftwareSerial**

HC-06連線速率：**9600bps**
HC-05連線速率：**38400bps**

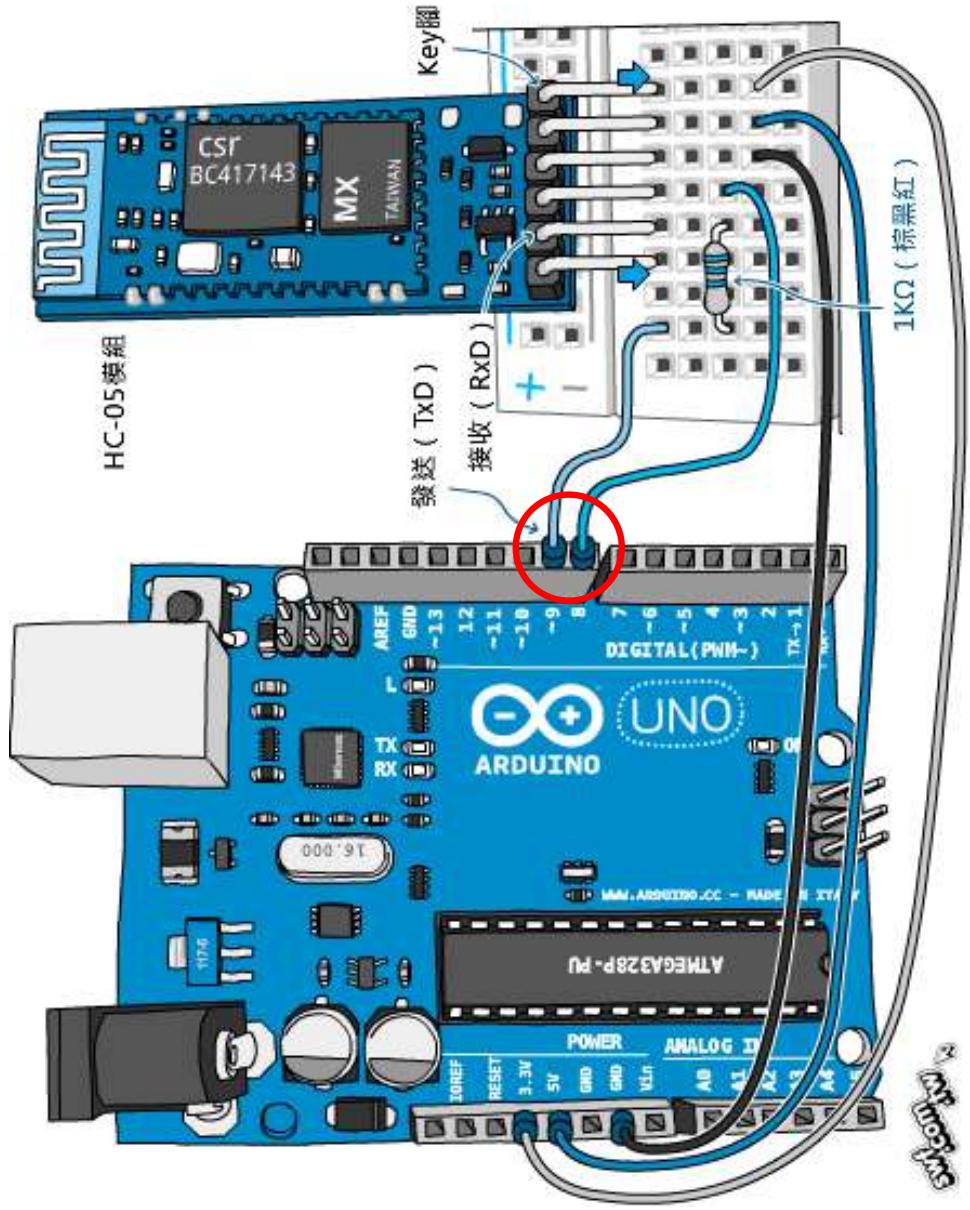


<https://swf.com.tw/?p=712>

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```
2 // 定義連接藍牙模組的序列埠
3 SoftwareSerial BT(8, 9); // 接收腳，傳送腳
4
5 char val; // 諸存接收資料的變數
6
7 void setup() {
8     Serial.begin(9600); // 與電腦序列埠連線
9     Serial.println("BT is ready!");
10
11 // 設定藍牙模組的連線速率
12 // 如果是HC-05，請改成38400
13 BT.begin(9600);
14 }
15
16 void loop() {
17     // 若收到「序列埠監控視窗」的資料，則送到藍牙模組
18     if (Serial.available()) {
19         val = Serial.read();
20         BT.print(val);
21     }
22
23     // 若收到藍牙模組的資料，則送到「序列埠監控視窗」
24     if (BT.available()) {
25         val = BT.read();
26         Serial.print(val);
27     }
28 }
```

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哇!CASA
藍牙、WIFI、Zigbee誰更適合物聯網，各有哪些優缺點？



IoT市場現況

Range (typical) 距離	Content distribution Focus on high data rates 傳輸率	Sense & control Low energy/long battery life 功耗	Proprietary solutions 解決方案	Typical applications 應用領域	Wide Area
< 10m/30ft	Bluetooth® 	Bluetooth® 	Personal appliances (wristband, smart watch, step counter, keyboard, mouse, pointer, etc.)	Indoor networks (internet, email, phone, security, energy management, home monitoring, etc.)	Short Range
< 100m/300ft	WiFi 	zgbee 	zigbee 	Indoor networks (internet, email, phone, security, energy management, home monitoring, etc.)	Local Area
Outdoor (Km/Miles)	5G 	NB-IoT 	LoRa 	Outdoor networks (phone, chat, internet, smart city, industry 4.0, agriculture, smart logistics, etc.)	Wide Area

<https://www.edn.com/iot-connectivity-wi-fi-and-bluetooth-are-winning/>

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未來市場預估

Range (typical) 距離	Wearables	Home	Phone	Outdoor (Km/Miles) 室外網路
< 10m/30ft	Bluetooth® 	WiFi 	Phone 	Outdoor networks (phone, chat, internet, smart city, industry 4.0, agriculture, smart logistics, etc.)
< 100m/300ft	Bluetooth® 	zgbee 	Phone 	Outdoor networks (phone, chat, internet, smart city, industry 4.0, agriculture, smart logistics, etc.)
Indoor networks (internet, email, phone, security, energy management, home monitoring, etc.)	Personal appliances (wristband, smart watch, step counter, keyboard, mouse, pointer, etc.)	Indoor networks (internet, email, phone, security, energy management, home monitoring, etc.)	Indoor networks (internet, email, phone, security, energy management, home monitoring, etc.)	Indoor networks (internet, email, phone, security, energy management, home monitoring, etc.)

個人裝置

室內網路

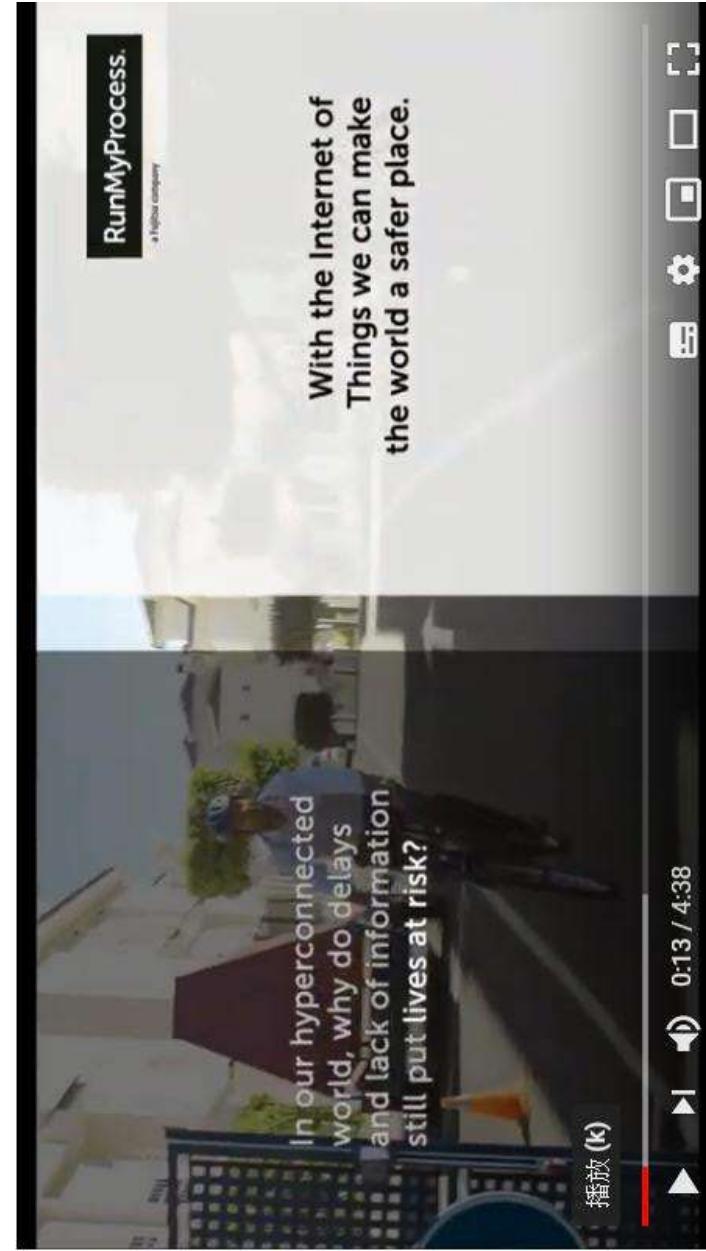
室外網路

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作業

- 請觀看p.96影片：
- 簡述故事情境（字數：200~300字）；
- 請列出兩項你覺得最有趣的物聯網應用。

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<https://www.youtube.com/watch?v=D1yW7-K-dfY>

1 You

commonly used wireless protocols in IoT



ChatGPT

Commonly used wireless protocols in IoT (Internet of Things) applications include:

1. **Wi-Fi (IEEE 802.11):** Wi-Fi is widely used for IoT applications that require high-speed data transfer and connection to existing Wi-Fi networks. It's suitable for applications like smart home devices, surveillance cameras, and industrial monitoring systems.
2. **Bluetooth Low Energy (BLE):** BLE is designed for low-power, short-range communication and is commonly used in IoT devices such as wearables, fitness trackers, smart sensors, and beacon technology for location-based services.
3. **Zigbee:** Zigbee is a low-power, low-data-rate wireless protocol ideal for IoT applications like smart lighting, home automation, industrial control systems, and environmental monitoring. It supports mesh networking, allowing devices to relay messages and extend coverage range.
4. **Z-Wave:** Z-Wave is another low-power wireless protocol commonly used in home automation and IoT applications. It operates in the sub-1 GHz frequency band, providing longer range and better penetration through walls compared to 2.4 GHz protocols like Wi-Fi and Zigbee.
5. **LoRaWAN (Long Range Wide Area Network):** LoRaWAN is designed for long-range, low-power communication and is suitable for IoT applications requiring connectivity over large distances, such as smart agriculture, asset tracking, and smart city projects.
6. **NB-IoT (Narrowband IoT) and LTE-M (LTE for Machines):** These cellular IoT technologies offer low-power, wide-area connectivity and are suitable for IoT applications that require coverage in remote areas or where existing cellular networks are available.
7. **Thread:** Thread is an IP-based wireless protocol designed for IoT applications, particularly those requiring reliable and secure communication between devices. It is based on IEEE 802.15.4 and is optimized for smart home automation and control.

企業人才技能認證 (TQC)

06. 歐洲電信標準協會（European Telecommunications Standards Institute, ETSI）將物聯網劃分為三個階層，由下至上應為下列哪一項？

- (A) 應用層、感知層、網路層
- (B) 網路層、感知層、應用層
- (C) 感知層、應用層、網路層
- (D) 感知層、網路層、應用層

07. 在歐洲電信標準協會定義的物聯網架構中，數據分析（Data Analysis）是屬於下列哪一層的技術？

- (A) 實體層
- (B) 應用層
- (C) 網路層
- (D) 感知層

08. 下列哪些不屬於感知層的技術？（複選）

- (A) ZigBee
- (B) HSDPA
- (C) RFID
- (D) QR Code

13. 關於智慧電網，下列敘述那一項錯誤？

- (A) 智慧電網感知層可提供追蹤能源消耗的高峰和通知忘記關閉設備的服務
- (B) 智慧電網網路層負責運送資料到整個網路的控制中心
- (C) 智慧電網應用層負責將電量使用資訊透過網際網路傳至配電者的資料蒐集中心
- (D) 智慧電網應用層可以提供電量消耗視覺化的服務，將智慧電網所蒐集到之用電資訊，透過圖表方式呈現

24. 一般而言，物聯網的應用技術可分為四大類，除智慧生活外，尚有下列哪些？（複選）

- (A) 智慧運輸
- (B) 智慧醫療
- (C) 智慧電網
- (D) 綠色建築

28. 下列哪一項是悠遊卡所使用的感測技術？

- (A) ZigBee
- (B) Wi-Fi
- (C) RFID
- (D) NFC

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31. 下列哪些是手機的作業系統？（複選）

- (A) Android
- (B) iOS
- (C) Windows Phone
- (D) Inventor

32. 下列哪一項是智慧型手機尋找附近餐廳的主要技術？

- (A) 三軸加速度計
- (B) 衛星定位系統
- (C) 陀螺儀
- (D) 超音波

33. 下列哪些是智慧型手機的應用？（複選）

- (A) 訂購網路商品
- (B) 查詢客戶資料
- (C) 當作電子錢包，進行小額付款
- (D) 將資料儲存在雲端硬碟

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34. 下列哪一項不是智慧型手機在 NFC 上的應用？

- (A) 在行動支付中，縮短交易時間
- (B) 在運輸中，取代實體通行證
- (C) 在交通中，規劃路徑，縮短行車時間
- (D) 在信用評價中，取代實體會員卡

35. 下列哪些為 ZigBee 網路層支援的網路拓樸？（複選）

- (A) 星狀拓樸
- (B) 樹狀拓樸
- (C) 環狀拓樸
- (D) 網狀拓樸

36. 下列哪一種標準的媒體存取控制層包含在 ZigBee 的全功能裝置中？

- (A) IEEE 802.3
- (B) IEEE 802.11n
- (C) IEEE 802.15.4
- (D) IEEE 802.20

20. 下列哪一項不是物聯網用於智慧醫療的 RFID 醫療器材管理應用？

- (A) 血袋
- (B) 手術器材
- (C) 針筒
- (D) 批價

37. 下列哪一項不是目前最常使用的無線通訊技術？

- (A) Bluetooth
- (B) IrDA
- (C) IEEE 802.11
- (D) ZigBee

38. 下列哪些是藍牙（Bluetooth）的特性？（複選）

- (A) 成本低
- (B) 長距離
- (C) 效益高
- (D) 隨意無線連接

40. 下列哪一項為 Wi-Fi 所採用的標準？

- (A) IEEE 802.3
- (B) IEEE 802.11
- (C) IEEE 802.15
- (D) IEEE 802.20

45. 一般商品包裝上都印製有條碼，台灣的國家代碼為下列哪一項？

- (A) 471
- (B) 886
- (C) 957
- (D) 977

50. 歐洲商品條碼（EAN）為防止讀取資料錯誤情形發生，必須有一檢查碼，它位於歐洲商品條碼（EAN）中的哪一個位置？

- (A) 最右邊
- (B) 最左邊
- (C) 中間
- (D) 上面